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PUTTING INTERNET-OF-THINGS AT THE SERVICE OF SUSTAINABLE AGRICULTURE. CASE STUDY: SYSAGRIA

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Abstract

Continuous growth of global population requires a better management of food resources: increasing productivity, maximizing crop yields, reducing losses (water, energy, chemicals), protecting the environment, preventing plant disease, minimizing the manpower. Since the mid-1980s when precision agriculture has its roots, the new concept could rely on advancement in electronics, agriculture research and emerging technologies. Syswin Solutions has been focused on Internet-of-Things, since it seems to be more adequate compared to drones or satellite imagery because it offers much more complete data from sensors placed directly in the cultivated environment. Thus, was born SysAgria, a system that provides comprehensive, real-time environmental information and development conditions at various phenological stages of crops, fruit trees, vines and vegetables, on the basis of which proactive treatment, planned fertilization, sowing and harvesting can be achieved. The system monitors the vital parameters of soil, air and light and identifies prototypes through a series of intelligent algorithms that analyze the data obtained and correlates them with a relevant history of the culture. Built using very low power consumption circuits, the system is energetically independent since it uses solar power and optimized algorithms for communication. Data is available anywhere in the cloud, thus the farmer can act immediately if parameters change. Syswin Solutions has five systems under test in real operating conditions, in different places around Romania, in greenhouse and in field, for monitoring cereals and vegetables. The paper presents the SysAgria system and some eloquent results of the monitoring. Soil sensors placed at different depths revealed possible water absorption problems. The automation of the ventilation in the greenhouse has been shown to be beneficial for plant development.

Key words: internet of things, precision agriculture, sensor, energy independent.

Even from the end of the last century the scientists understood that the humanity's chance to provide food to a growing population in conditions of diminishing water and fossil energy resources is precision agriculture (PA). Also known as precision farming, satellite farming or site-specific crop management, the concept presumes continuous monitoring of the parameters influencing the plants' growth. Monitoring, meaning observation, measurement and action, is referred to many agents like air, light, plant disease, soil, water. Because, as was pointed out in an earlier survey (Zhang N. *et al*, 2002), agriculture production systems have benefited from technological advances previously developed for other industries, nowadays it can be understandable that the transition from Industry 4.0 to Agriculture 4.0 is quite natural. One of the emerging technologies is the Internet of Things (IoT) which is increasingly penetrating agriculture (seen in a broader sense: vegetable growing,

horticulture, fruit growing, viticulture, but also animal husbandry, beekeeping and fish farming, a.s.o.). Thanks to IoT a great deal of information provided by a wide variety of sensors is available everywhere, anytime. The development of an information and communication network appears to play a vital role in the progress of precision agriculture, overcoming barriers such as the lack of basic data and farm oversight as well as non-compatibility and standalone systems (Lutticken R. E., 2000). In livestock monitoring, ranchers can use wireless IoT applications to gather data regarding the health, well-being, and location of their cattle. The main benefit is the possibility to identify sick animals and to extract them from the herd to prevent the spread of the disease. A common application of IoT is the monitoring of plant and soil conditions. The main benefits of such applications are a better management of the resources (water, fertilizers) by sensing the soil moisture and nutrients, determining the optimal

¹ Syswin Solutions SRL, Bucharest, Romania

time to plant and harvest and predicting possible plant disease situations. The highest efficiency of IoT applications in agriculture is when the most appropriate sensors are chosen and when data interpretation benefits from correlations between different parameters.

A recent study on 1 ha potato plot on wireless sensors network (WSN) measuring soil temperature and humidity, the most important parameters for this culture, was conducted to determine how the response to applications is determined by measurements of performance in wireless communications (Petearson Anzola J. *et al*, 2017). The specificity of this study was the large number of network sensors (100) placed on a restricted area. Even though the results obtained do not help to directly improve potato crop performance or production, they help engineers to estimate how long it would take a user to obtain the “real time” crop data for a given query or how long a server or machine can obtain a temporary crop response, items that are of great importance in IoT applications. One solution to avoid blocking when in case of a big amount of data is a special architecture proposed for dynamic processing of events in the context of IoT and PA which was implemented in a virtual machine with a 1.9 GHz CPU and 6 GB RAM and successfully tested for fifteen days into an intelligent irrigation system (Mazon-Olivo B. *et al*, 2018).

Since the work is presented at a conference held at the National Research and Development Institute for Potato and Sugar Beet, a funny experiment should be mentioned: Potato-powered IoT, whose idea was to test how less power would be needed for supplying a WSN (Lozano Fernandez J. *et al*, 2015). IoT technology is associated with low-power, so the circuits could also be fed from potatoes, but that's a false impression: just as the whole lead-free technology is considered to be more thermally aggressive because the most used alloy, SAC, requires more than 30°C heat than SnPb alloy, as there are other lead-free alloys whose melting temperatures are even lower than that of SnPb, so there are sensors connected to WSNs requiring more powerful sources (batteries, photovoltaic cells, a.s.o.).

Syswin Solutions has developed SysAgria, a complete system based on IoT technology for monitoring vital parameters from soil, air, light by means of sensors spread over an area of interest, for data collection and transmission to a remote central unit where there are analyzed in order to offer the results of the measurement, as well as the interpretation and recommendation for the farmer (*figure 1*). The processed information can be accessed from fixed or mobile devices. The system

consists in at least one base station (SysAgria 1, ... SysAgria n) that constitute the nodes of a Wireless Mesh Network (WMN), each node communicating with each other and through a gateway with a server, which assures the interconnection to the Web. Each node controls all the sensors by wire mainly interconnected on serial buses (I2C, RS-485). The system does not only perform detection, measurement of parameters, but also can generate commands through an IC interface for other equipment (fans, windows, pumps) in greenhouses or irrigation systems (this is an option). Besides greenhouses, it can also be installed in grain fields, vegetable gardens, flower gardens, orchards, vineyards, a.s.o. The supply voltages are obtained from a power unit consisting of a rechargeable battery (12V, 9Ah) and a photovoltaic panel (50W); where electromechanical devices are required, the power is supplied from external voltage sources (230V/50Hz).

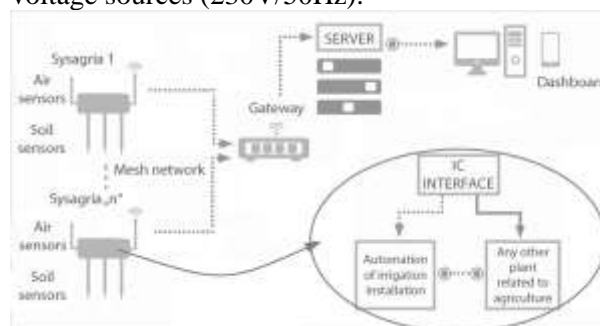


Figure 1 SysAgria bloc diagram

MATERIAL AND METHOD

Constructively, the base station is made up of an IP 67 grade cabinet in which the electronic module containing the processing and control block is placed, including analogue to digital converters and communication block, the IC interface module, the battery and the battery charger from the photovoltaic panel. The photovoltaic panel is mounted at a sufficient height not to be overshadowed by vegetation or other natural obstacles and facing South.

The processing and control block is built around an advanced RISC microcontroller, AVR architecture, ATmega2560 (Microchip Technology) working at 16 MHz. Its main characteristics are: 256KBytes of In-System Self-Programmable Flash memory, 4 KBytes EEPROM, 8 KBytes internal SRAM, 16-channel, 10-bit ADC, 10 digital communication peripherals (4 USART, 5 SPI, 1 I2C), ultra-low power consumption (0.1μA at 1.8V), temperature range (-40°C to 85°C). For wireless communication the base station supports a Long Range low power (LoRa) transceiver module RFM98W - 433MHz (Hoperf Electronic), as well as a GPRS module equipped with SIM800C (SIMCom) circuit. The communication within the WMN is based on LoRa technology which offers to SysAgria system several advantages:

- allows long range distance between the nodes, up to 15 – 20 km, so a single central unit can monitor large areas or smaller dispersed areas;
- the frequency range used by LoRa is part of the unlicensed ISM band, so the communication between the nodes is costless;
- the very low power consumption allows a better management of the energy so the system can work even in the case of several cloudy days.

The sensors are outside the cabinet, buried in the soil or placed at different heights over the ground level and they are connected to the electronic module through rugged connectors. SysAgria base station allows the connection of up to 92 sensors.

Because the most sensible part of the system is sensory, SysAgria does not use home-made sensors but only certified sensors produced by renowned specialized firms, such as Honeywell, Atlas Scientific, RIKKA Electronic Technology. The sensors are measuring parameters of soil (moisture, temperature, pH, electroconductivity), air (temperature, relative humidity, speed and direction of the wind, barometric pressure, rainfall, leaf wetness, leaf temperature), light (ultra-violet index, solar radiation, illuminance). SysAgria can perform some measurements up to three (or more, if requested) levels in depth of in height. This allows a more accurate mapping of the parameters, not only horizontally, but also vertically. It is known, for example, that in the first period of vegetation the superficial rooting of onion requires a soil moisture level of around 80-90% of field capacity at 30-40 cm depth, until bulb formation, i.e. in the period of intense growth of roots and leaves.

SysAgria was previously tested in the Laboratory. The scope of this testing was to verify the capability of the system to control each sensor, to perform the measurement of the parameter, to display its value on a monitor and to compare with the measurement performed with another instrument. The most laborious task, already presented in another paper (Zarnescu A. *et al*, 2018), was the pH measurement in the soil, which required a prior calibration with known pH solutions and comparison with the measurements made with a tool of greater precision. The security of system is assured by data encryption using a hardware crypto engine and by using a cabinet with keyed door, open door detection and alert, and vibration sensor for SysAgria base station.

Due to the specificity of the application, tests in an electronics laboratory can cover only a small part of the system's functionality, so that real-time testing activities have been initiated. Five SysAgria systems were tested in different places, with different types of soil and plant cultures (*figure 2, figure 3*). The configuration of the SysAgria systems under test is presented below (*table 1*).

The purposes of the testing were:

- to verify the capability of monitoring from the distance the main parameters for agricultural lots;
- to test the integration of the system within other automation systems (e.g.: ventilation);
- to verify the system's energy independence.
- to improve the data analysis algorithm in accordance with the specific conditions;
- to observe the expected positive impact of the system on the monitored cultures.



Figure 2 SysAgria cabinet installed in a field



Figure 3 SysAgria cabinet installed in a greenhouse

The particularity of the #1 system is that it has the option of automation implemented: according to the air temperature, the system may command the open/close of the curtains and the start/stop of a fan.

Table 1

The configuration of the SysAgria systems under test

No.	Location	Culture	Type	Sensors (total)
1	Cocorastii Colt	Chinese cabbage	greenhouse	Soil humidity, soil temperature, air temperature, relative humidity, wind speed, wind direction (6)
2	Chirnogi	corn	field	Soil humidity, soil temperature, soil pH, air temperature, relative humidity, wind speed, wind direction, rainfall, barometric pressure, solar radiation, leaf wetness, electroconductivity (29)
3	Calarasi	soybean	field	Soil humidity, soil temperature, soil pH, air temperature, relative humidity, wind speed, wind direction, rainfall, barometric pressure, solar radiation, leaf wetness, electroconductivity (24)
4	Turda	wheat	field	Soil humidity, soil temperature, soil pH, air temperature, relative humidity, wind speed, wind direction, solar radiation, leaf wetness, electroconductivity (14)
5	Arad	hazelnut tree	orchard	Air temperature, relative humidity, solar radiation, leaf wetness, rainfall, soil temperature, humidity, pH and electroconductivity (9)

The particularity of the #3 system is the ability to measure some parameters at three different levels: the air temperature and relative humidity at the heights of 0.3m, 0.7m, 1.1m, evapotranspiration and temperature on the leaf at 0.25m, 0.7m, 1.1m, soil moisture, temperature, pH and electroconductivity at depths of 0.15m, 0.25m, 0.35m. Due to the IoT facilities, data from the 5 locations could be retrieved and viewed also on a computer located at the company's headquarters in Bucharest in order to supervise SysAgria systems behavior (figure 4). These prove the capability of SysAgria system to cover large areas. Along with the data on monitored parameters, information is also provided about the equipment that is useful for maintenance such as battery voltage, RF signal power, GPRS battery charging status, the last transmission time and system's ID. Data can be stored locally or in the cloud on the Syswin Solutions server.



Figure 4 The territorial locations of the SysAgria systems under test

RESULTS AND DISCUSSIONS

Five systems were installed between June and August and they are still under testing, totaling 14,237 hours of operation. Communication was sometime lost due to telecom operators. There are differences between the technological levels of national operators: the system #5 worked better on 2G offered by an operator than on 3G from another. However, during the loss of communication, the system is still working and able to control the automation.

At the system #1, the wind sensors detect its speed and the direction; if the speed is higher than 8m/s the system will command the closing of the curtain from the wind. This will prevent a sudden change in temperature within the greenhouse. On the other side, if the speed is 1 – 2 m/s, the movement of the wind vane has a random move and the direction of the wind is unusable. The wind sensor support is located at a height of approximately 6 m (figure 5). Probably it should be placed higher in order not to be affected by the air flowing from the roof. The functionality of the automation is proved using the monitoring data

from August 11, 2018, from 08:30:20 to 20:00:30. Every minute after reading the air temperature the microcontroller computes the mean value of the last 10 measurements and compares to a pre-set threshold (27.5°C). If the value is greater, the system will command the opening of the curtain up to 10%.



Figure 5 Wind sensors installation in a greenhouse

If the temperature increases, the opening will continue up to 100%. In this situation, the temperature is compared to another threshold (29°C) in order to start forced ventilation using a fan. However, the forced ventilation can be initiated whenever necessary (figure 6), but the air temperature in the greenhouse cannot be less than the ambient temperature without using a cooling agent. During the 11 hours of monitoring, the temperature in the greenhouse varied between 23.93°C and 34.43°C, while the AccuWeather site reported 30°C for that day. During the testing period, the algorithm was improved several times; for example, in order to reduce power consumption; if the fan should be working continuously, it will be commanded intermittently: 15 min on, 5 min off.

Certain parameters do not change quickly, such as soil pH. Usually, farmers do testing of the soil pH once, twice or even several times a year and they have to call a specialized lab. SysAgria allows reading anytime is needed. However, account must be taken of the operation principle of the pH sensor. Even if the manufacturer says the pH sensor can stay indefinitely in the field, the readings should not be trusted indefinitely: only when the probe is immersed in a solution prepared in the soil with the same water used for irrigation. After three hours from the installation of the system #3 (July 19), when the reactions were stabilized, the readings at a depth of 0.15m in the soil were performed and remained stable within the range 6.69pH \pm 0.25pH almost 10 days. This is a good value since soybean can be grown in soils with a pH between 5 and 8.5 (optimum 6.7pH, Serban D., 2008). During this time (July - August) there were no fertilization operations, but only a pest treatment that had no effect on the measurements.

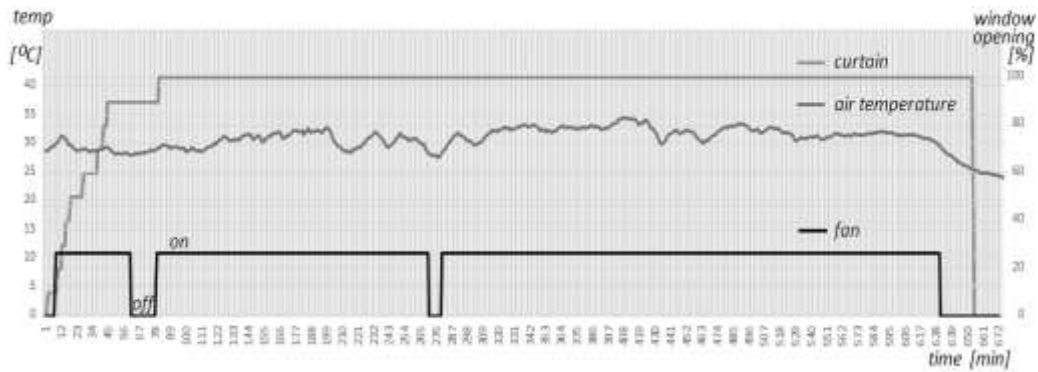


Figure 6 The correlation between air temperature and the automation of ventilation in the greenhouse

Although the measurement procedure requires a minimal intervention, the great benefit is that the result of the pH measurement is automatically transferred to the remote system database and processed. SysAgria allows monitoring of parameters, storing data in a database and consulting it for analysis at any time. Information can be tabulated or graphical. *Figure 7* presents the variation of air temperature, soil temperature and soil humidity in a greenhouse. It can be observed that the soil temperature is lower than air temperature during the day and becomes greater during the night confirming the capacity of heat accumulation by the soil. The system installed in the greenhouse allows to maintain a certain air temperature by controlling fans (forced cooling) or curtains (natural cooling), even it cannot be lower than outside air temperature.

Figure 8 presents the variation of soil moisture expressed in water volumetric content at three different depths, 0.15m, 0.25m and 0.35m, during a period of two months, June 1 – July 31, 2018 (system #3). The soil moisture at 0.35m depth is approximately constant (49%), decreases at 0.25m, and increase again at 0.15m from the surface, (~40%). The tendency of decreasing humidity at 0.25m under the ground can be attributed to water absorption by the roots - knowing that soybean develops about 75% of its root mass at 0.30m depth – and to a poor ascending stream of water to the roots of the plants. The soil at site #3 is recovered from a pond in the Danube meadow very rich in shellfish and snail and snail residues (figure 9).

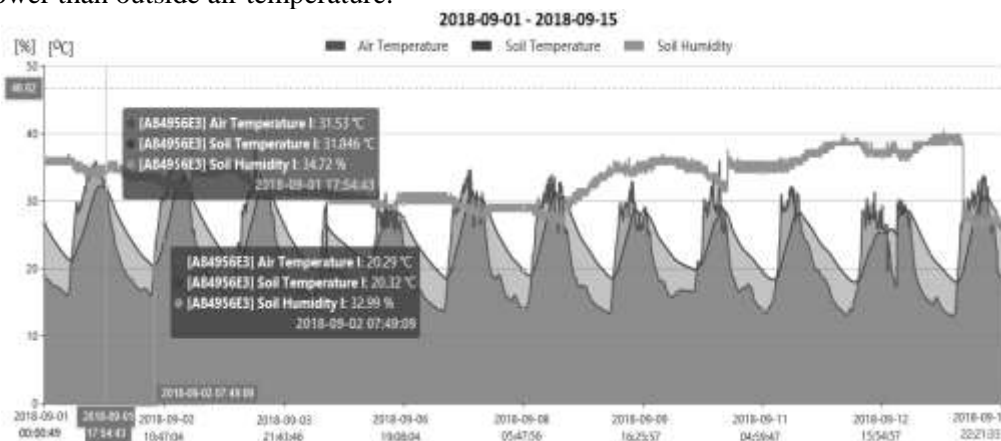


Figure 7 Diagram of the variation of some parameters in the greenhouse

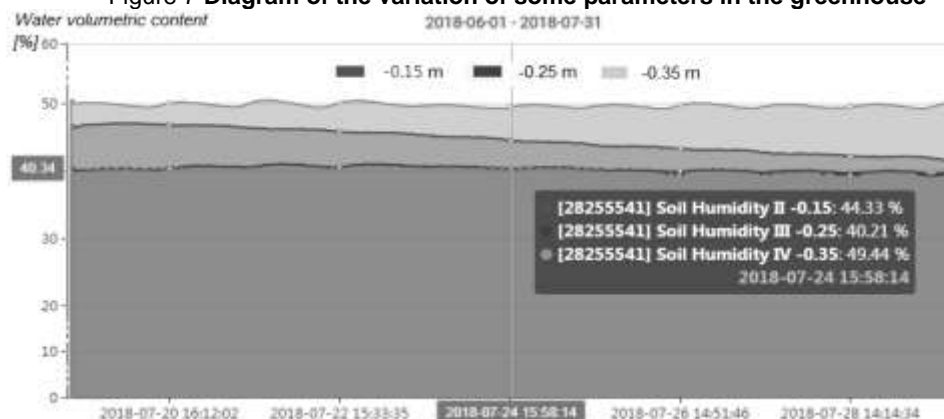


Figure 8 Diagram for three level monitoring of soil humidity



Figure 9 **Three level soil moisture measuring (site #3)**

The depths of the measurements have been established by the needs of the beneficiary, but it can be any depending on the type of culture; for example, sugar beet, in soils with the most favorable texture, develop deep roots that can reach up to 1.20m (Vatamanu V., 2014).

No failure of any system due to lack of energy was recorded. This proves that the systems were well-sized in terms of energy.

The system can offer Notification to the user if some conditions occur. However, the farmer is responsible to set the thresholds of the parameters according to local conditions. In the future, based on collaboration with agricultural specialists, SysAgria will be improved with an advanced data analysis in order to make predictions and to offer solutions to problems.

CONCLUSIONS

The system is available 24/24 hours, 7/7 days without the need for an external power supply. Temporary lack of communication due to radio wave propagation conditions does not affect the behavior of the system; the commands are sent to the automation system, data are stored locally and retransmitted when the connection is restored.

The efficiency of the system #1 was reported by the farmer itself: in a short time, the cabbage in the greenhouse grew very well and nice compared to those cultivated in the field and were not affected by the disease (*figure 10*). This is one of the positive impacts expected from SysAgria.

SysAgria enables the integration of automated control and command systems to function as a decision maker and timely operation on automated irrigation and fertilization systems, ventilation systems, dehumidification, lighting, especially for solariums and greenhouses.

Due to the many types of air sensors, the system can work as weather station too.

SysAgria was thought to be a tool in the service of the farmer based on electronic technology and knowledge in the field of agriculture. The ability to control different types of soil sensors placed on different depth, air and light

sensors and supplied by a considerable computing power could make SysAgria a useful tool in research activities.



Figure 10 **The cabbage culture from the greenhouse**

ACKNOWLEDGMENTS

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TECHNICAL ASPECTS OF SYSTEMATIC CADASTRAL WORKS PERFORMED ON CADASTRAL SECTORS

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Abstract: The execution of topographic measurements for the real estates from the cadastral sectors of the territorial administrative units is part of the integrated cadastral and land registration system. This unitary general cadastre system includes 3,181 territorial administrative units at national level, more precisely: 103 municipalities, 217 cities, 2,161 communes and 12,957 villages. The present stage of the systematic cadastre consists in implementing *The National Programme for Cadastre and Land Registration 2015 – 2023*. These works are performed by specialized professionals and financed by the *National Agency for Cadastre and Real Estate Advertising*. The legal frame for the general cadastral works in Romania is regulated by the *Law on Cadastre and Real Estate Advertising no.7/1996, with all the subsequent modifications and completions*. In the case of Iasi County, which covers a total surface of 5,477 km², there are officially identified 98 administrative territorial units, which include: 2 municipalities, 3 cities, 93 communes and 418 villages. The ongoing operations at the level of the cadastral sectors of Iasi County include 52 territorial administrative units and cover a surface of almost 63,000 ha. This sums almost 87,000 owners. The selected case study highlights the cartographic and legal aspects of the technical documentation drawn up for the cadastral sector no. 22 (strip of land no. 46). From Holboca commune, Iasi County. The delimited and measured surface for this cadastral sector was of 173.3235 ha, with 244 real estates identified and a road used for agricultural purposes. The limits of this cadastral sector and of the real estates included, respectively, were set on the field, based on the identification provided by their legal owners. After processing the specialized studies, it resulted the graphic and alphanumerical data base for one cadastral sector. This data base represents the base for the opening of land registers and the official records of real estates and owners.

Key words: systematic cadastral works, land register, technical and legal data base, cadastral sectors and real estate

The implementation of the integrated cadastre and land registration system for the real estates from cadastral sectors represent the main goal for bringing to an end the specialized works conducted in the administrative-territorial units.

In 2019, the National Cadastre and Land Registration Program reached its fifth financing stage, for both its incorporated and unincorporated activities. By implementing these cadastral works for the 3,181 administrative-territorial units of Romania, the real estates are registered and described.

The systematic real estate registration program is financed for the territorial administrative units by the *National Agency of Cadastre and Real Estate Advertisement*. At the same time, it is also mentioned the financing received from the *European Fund for Regional Development*, allocated mainly for the cadastral system of rural areas.

The legal framework for conducting the specialized works is regulated by the *Cadastre and*

Real Estate Advertisement Law no. 7/1996, with the subsequent modifications and completions.

Following the finances assigned between 2015-2019 the systematic cadastral works have been completed for all the basic administrative units and also for some cadastral sectors from the incorporated and unincorporated areas.

The systematic cadastral works conducted on cadastral sectors until **September 10th 2019** were concluded for a total number of **13 485,815** real estates, managed in the integrated cadastre and land registration system.

The properties recorded at the *National Agency of Cadastre and Real Estate Advertisement* represent nearly **34%** of the approximately 40 000,000 real estates estimated at national level.

From the systematic registration activity conducted until **September 10, 2019** it resulted the process was completed in **69 administrative - territorial units** from **21** counties (<http://www.ancpi.ro/pnccf/>).

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Presently the ongoing cadastral activity is conducted, at national level, **2 298 administrative – territorial units**, the equivalent of nearly **72% of the total basic units**.

In the area corresponding to the administrative territorial unit of Iasi County, that covers a total surface of **5,977 km²** there are registered **98 basic administrative units**. They include: **2 municipalities, 3 cities, and 93 communes**, with **418 villages** (The Statistical Yearbook of Romania, 2018).

The registration of the real estates in the integrated system of cadastre and land registration was started at the end of 2015. The first administrative territorial units nominated by the *National Agency of Cadastre and Real Estate Advertisement* for implementing the systematic cadastre were the communes **Dumesti, Lețcani and Movileni**. Along with the three units of Iasi County there were also nominated 62 other administrative territorial units.

Following the European funds allocated in September 2018 the systematic registration of real estates on cadastral sectors expanded to another 23 administrative territorial units of Iasi County. At the same time, the *Cadastre and Real Estate Advertisement Office of Iasi* draw up the financing contracts for the systematic registration of real estates with another 52 administrative territorial units. In his context, the surveys estimated cover approximately **87,000 real estates**, with a total of almost **63,000 hectares**.

The conclusion of this process consists mainly in the registration of the agricultural lands from rural areas. At the same time, the surveying is ensured as well as the registration of the real estates in the digital data base of the land register.

The present status of the ongoing works from Iasi County point out, according to the technical data provided by the *National Agency of Cadastre and Real Estate Advertisement*, they have expanded in **70 administrative-territorial units**, from the total of 98 basic units (*figure 1*).

MATERIAL AND METHOD

Cadastre and land registration have experienced, over time, various development periods and stages (Boș N., Iacobescu O., 2009).

Considering the organizational and legal context existent in the 100 years interval that passed from the Great Union, three distinct periods have been identified: 1918–1950, 1951–1989 and 1990–2018 (Moca V. *et al*, 2018).

Nowadays, the unitary cadastral and land registration system is implemented for the entire territory of the basic administrative territorial units

and also for some incorporated or unincorporated cadastral sectors (Moca V. *et al*, 2018).

For the present case study the technical cadastral operations have been conducted on the real estates identified in the cadastral sector from the *unincorporated area of the administrative-territorial unit of Holboca, Iasi County*. This commune is situated in the south-eastern part of Iasi County, in the eastern part of the municipality.



Figure 1 The ongoing systematic registration activity for the real estates from the territorial administrative units of Iasi county (According to ANCPI, 2019)

The total surface of the administrative-territorial unit of Holboca includes **5,002 hectares**, including the unincorporated area and the following seven incorporated areas: *Holboca, Dancu, Valea Lungă, Rusenii Noi, Rusenii Vechi, Orzeni și Cristești* (Cârdei Mihaela, 2013).

The information for the technical data base used in the identification, delimitation, cadastral measuring and representation of real estates on the cadastral plan was conducted, for the **cadastral sector no. 22 (strip of land no. 46)** in the unincorporated area of Holboca commune. For this cadastral sector covering **173.3235 hectares** there have been delimited **244 real estates** and an exploitation road.

The limits for the cadastral sector no. 22 and for the 244 real estates included were established based on the existent cadastral technical documentation and the on field identification of the legal owners. The systematic registration of the real estates is realized by specialized service providers according to the acquisition procedure.

By **Order no. 979/05.08.2016** it was regulated the way the systematic cadastral activity is conducted on cadastral sectors for the registration of real estates in the land register. They are financed by the *National Agency of Cadastre and Real Estate Advertisement*.

The specialty works for the cadastral sector no. 22 consisted in going through all the stages and the theoretical and practical technical operations.

The graphical and alphanumerical data included in this case study were taken from the

cadastral plan, scale 1:2000 of the cadastral sector no. 22. A plan section was selected from the graphic fund of this cadastral plan.

The delimited cadastral subsector with the **identification no. 22/1** included a total surface of **32.9975 hectares** and **43 real estates** used as agricultural land.

RESULTS AND DISCUSSIONS

Based on the cadastral delimitation of the existent boundaries between the basic administrative territorial units and the identification of the limits of the cadastral sectors from the Holboca area it was initiated the procedure for the systematic registration of the real estates from one cadastral sector.

The stages and the technical operations for the systematic registration of the real estates were

conducted on the *cadastral sector no. 22* situated in the unincorporated area of Holboca, according to the technical norms.

a. Cadastral delimitation and cartographic framing of the Holboca territory

The Holboca administrative-territorial unit was delimited by six basic territories. The total length of the borders' perimeter following the cadastral delimitation was of **44.190 Km**.

The cadastral delimitation of Holboca's territory included **six boundaries of the commune: Aroneanu and Golăiești in the North; Ungheni and Țuțora in the East; Tomești in the South; and the border with the municipality of Iasi, in the West, respectively (figure 2).**

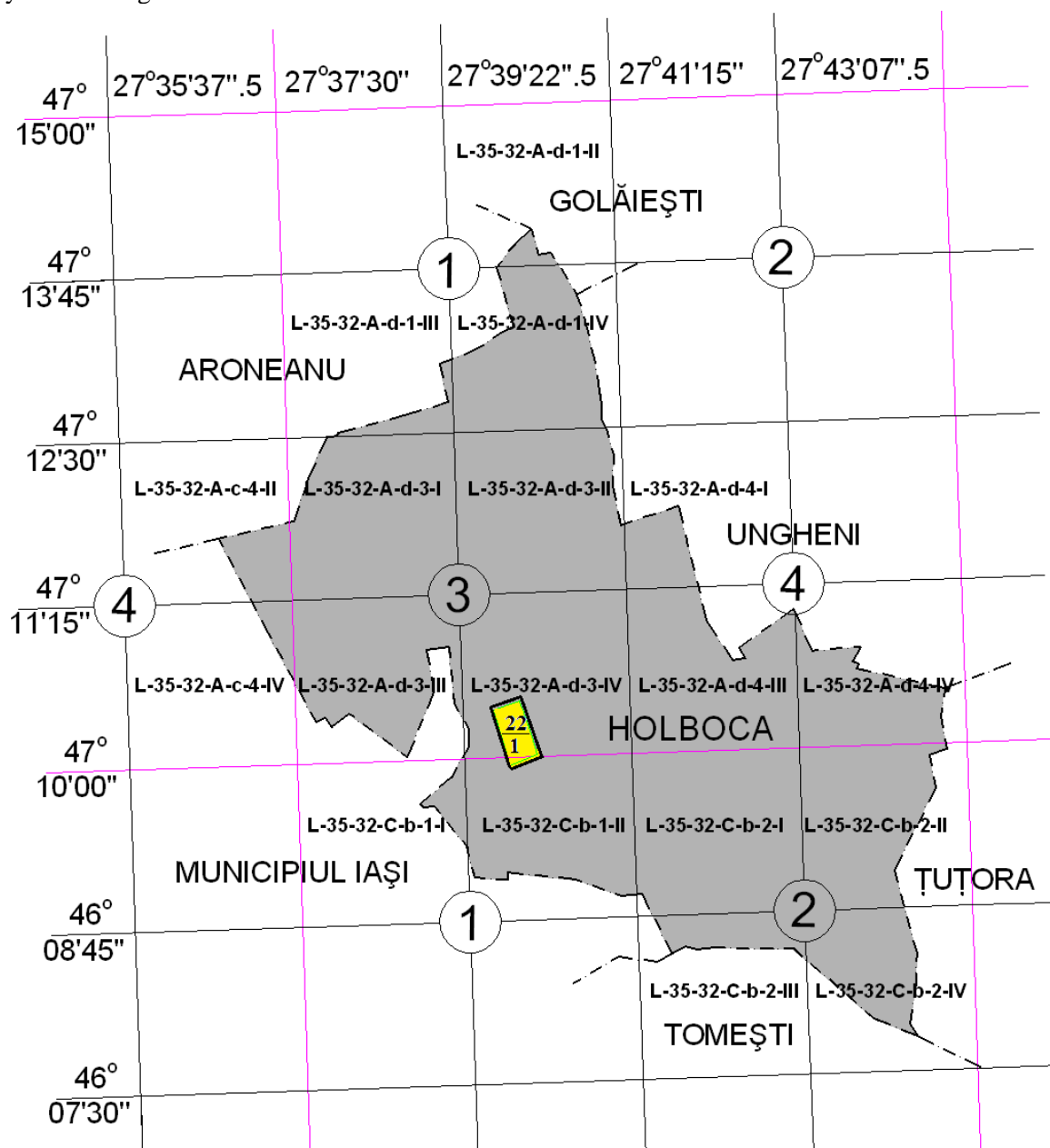


Figure 2 Cadastral delimitation and framing on geodetic trapeziums of the administrative-territorial unit of Holboca, Iași County, scale 1:5000

The real estates' graphic representation is drawn up using the national system of the **1970 Stereographic projection** and the **Black Sea - 1975** quota system. The accuracy of the graphic representation of the real estates' borders must respect the plan scale 1:5000 for the unincorporated areas and 1:2000 for the incorporates areas

The spatial distribution of the borders of the administrative-territorial limits of Holboca was cartographically framed on 7 trapeziums with scale 1:10000, 18 trapeziums with scale 1:5000 and 53 trapeziums with scale 1:2000.

The areas of the trapeziums (plan sheets) are determined based on the geographic coordinates of the four corners used as **control surfaces** in the general and systematic cadastre works, on cadastral sectors. In principle, the geodetic trapeziums areas that are determined based on geographic coordinates are not considered deformed in the 1970 - Stereographic projection plan. The graphic fund of the systematic cadastral activity that lead to the present case study of the **cadastral sector no. 22** (strip of land no. 46) was represented cartographically on two trapeziums: **L-35-32-A-d-3-IV** and **L-35-32-C-b-1-II**.

Based on the graphic correlation with the control area of the geodetic trapeziums with scale 1:5000 of the total measured surface of **173.3235 ha** resulted the subsequent cartographic framing: 98.8% in the trapezium **L-35-32-A-d-3-IV** and 1.2% in the trapezium **L-35-32-C-b-1-II** (table 1).

Table 1
The surface of geodetic trapeziums and of the cadastral sector no. 22

Nomenclature of the geodetic trapezium	Trapezium surface	Subsector surface	
	ha	ha	%
L-35-32-A-d-3-IV	548.8071	171.3293	98.80
L-35-32-C-b-1-II	549.1220	1.9942	1.20
TOTAL	1097.9291	173.3235	100.00

The cadastral subsector no. 22/1 with the surface of **32.9975 hectares** and **43 real estates** was represented, on the **control area** of the two geodetic trapeziums at scale 1:5000 (figure 2).

The spatial distribution of the graphic fund included: 93.95% in the trapezium **L-35-32-A-d-3-IV** and 6.05% in the trapezium **L-35-32-C-b-1-II** (table 2).

Table 2
The surface of geodetic trapeziums and of the cadastral subsector no. 22/1

Nomenclature of the geodetic trapezium	Trapezium surface	Subsector surface	
	ha	ha	%
L-35-32-A-d-3-IV	548.8071	31.0036	93.95
L-35-32-C-b-1-II	549.1220	1.9939	6.05
TOTAL	1097.9291	32.9975	100.00

b. The execution of topographic measurements and drawing up the cadastral plan

For drawing up the present case study the preliminary stages of the systematic cadastre were respected. The one that stands out from all of them is drawing up the geodetic support system for cadastral measurements.

For the detailed topographic measurements on cadastral sectors and on real estates it is required the optimal density of the national geodetic network. The topographic measurements on cadastral sectors and real estates require adding to the points of the national geodetic support network **GPS – GNSS**, the necessary optimal density (Păunescu, C. et al, 2015).

For the Holboca administrative territorial unit it was used the **GPS (Global Positioning System)** measuring technology and the double frequency **SOUTH S82T** type **GNSS (Global Navigation Satellite System)** receiver. This receiver ensures the real time **RTK (Real Time Kinematic)** measurements in both **static** and **kinetic mode**.

Using the **Carlson SurvCE** software and the **ROMPOST RTK** service the absolute rectangular coordinates were determined for four new points of the **national geodetic support network GPS-GNSS**. This geodetic support base was used for the detailed topographic measurements on the cadastral sector.

The elevation of the topographic points situated on the limits of cadastral sectors with identification numbers 22 and 22/1, and of the included real estates was made using the points of the geodetic support network. On the detailed measurements it was used the **Leica Geosystems TC-705** total station.

The measurements processing for the topographic elevation network was conducted using the specialized program named **TopoSys**. This program ensures the automatic compensation of traversing and obtaining the absolute rectangular coordinates for the measured points. At the same time, the program gives the possibility of exporting the absolute rectangular coordinates in ASCII format and the export of the graphic fund in DXF format. The topographic measurements made for the **cadastral sector no. 22** (strip of land no. 46) served for drawing up the *digital cadastral plan* and also the analogical format, scale 1:2000.

The plan metric correlation of the plan rectangular coordinates of the 88 detail points relied on a geometric grid references of the plan with the lateral of 200m. On the surface corresponding to the borders of the *cadastral subsector no. 22/1* were assigned the cadastral numbers for the 43 real estates (figure 2).

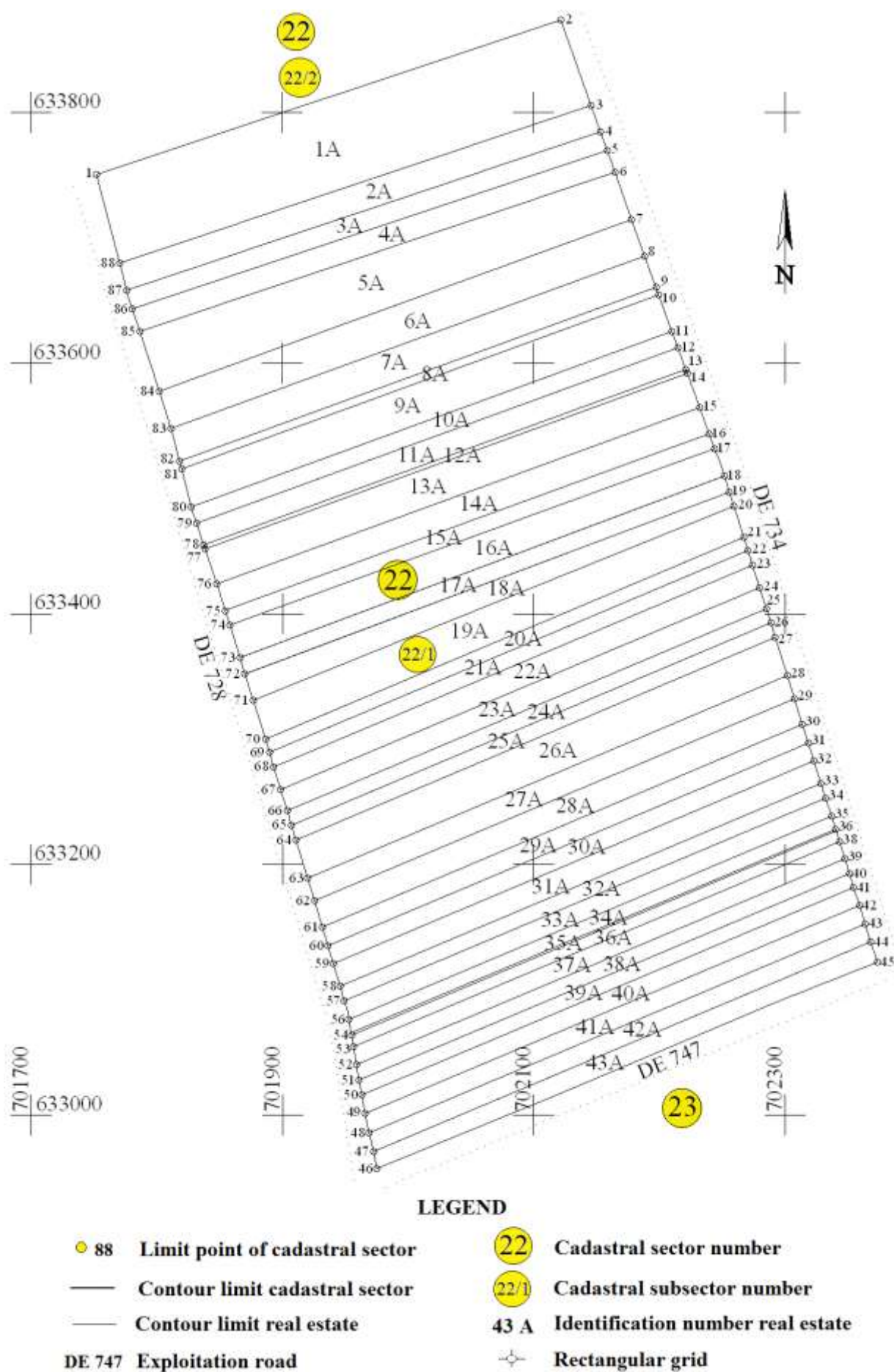


Figure 2 Cadastral plan for subsector no. 22/1 from Holboca administrative – territorial unit, scale 1:2000

c. Determining the measured surface for the cadastral subsector no. 22/1

The act of establishing the limits of a cadastral sector and of all the real estates included, respectively, represents one of the key preliminary operations.

This ensures the accurate reporting of the cadastral entity and the effective management of the graphic fund reported to the cadastral plan.

The limits identified on field, for the **cadastral subsector no. 22/1** are represented as linear elements established in time.

The plan *rectangular coordinates* (X, Y) of the points from the geometric contour line that were identified in the 1970-Stereographic projection system were used to calculate the surface of the cadastral subsector no. 22/1.

In this context there were also used the rectangular coordinates of the 88 points situated on the unenclosed limit of the geometric contour of the cadastral sector. Based on the on field measurements it resulted a surface of **32.9975 hectares** that is to be registered in the primary technical database of the administrative territorial unit of Holboca (Table 3).

Table 3

The measured surface and the perimeter of the cadastral subsector no. 22/1

Point no.	Rectangular coordinates		Distances (m) D(i, i+1)	Point no.	Rectangular coordinates		Distances (m) D(i, i+1)
	X (m)	Y (m)			X (m)	Y (m)	
1	701752.291	633750.614	389.60	45	702373.427	633122.396	430.91
2	702121.876	633873.893	72.20	46	701975.273	632957.595	13.68
3	702145.907	633805.809	22.17	47	701972.365	632970.968	15.52
4	702153.286	633784.904	15.82	48	701969.067	632986.138	15.57
5	702158.551	633769.988	18.86	49	701965.758	633001.355	15.16
6	702164.829	633752.202	39.81	50	701963.118	633016.284	12.11
7	702178.077	633714.667	31.20	51	701961.099	633028.220	12.15
8	702188.503	633685.264	26.33	52	701959.071	633040.203	14.75
9	702197.341	633660.460	6.47	53	701956.610	633054.750	9.21
10	702199.543	633654.374	31.05	54	701955.073	633063.836	1.90
11	702210.108	633625.175	13.94	55	701954.756	633065.707	10.82
12	702214.851	633612.068	18.15	56	701952.950	633076.380	15.41
13	702221.027	633594.999	3.43	57	701949.244	633091.337	12.09
14	702222.193	633591.777	29.04	58	701945.768	633102.919	18.72
15	702232.074	633564.469	22.54	59	701940.388	633120.849	15.25
16	702239.744	633543.271	12.09	60	701936.005	633135.457	15.50
17	702243.856	633531.905	23.52	61	701931.550	633150.302	21.58
18	702251.858	633509.791	13.11	62	701925.348	633170.970	19.14
19	702255.963	633497.339	11.92	63	701919.846	633189.305	31.72
20	702259.525	633485.965	26.40	64	701910.730	633219.684	12.35
21	702267.419	633460.768	10.74	65	701907.181	633231.510	12.14
22	702270.628	633450.523	11.98	66	701903.691	633243.142	17.48
23	702274.258	633438.937	18.93	67	701898.666	633259.885	18.94
24	702279.917	633420.874	17.46	68	701893.105	633277.988	12.15
25	702285.136	633404.214	12.13	69	701889.511	633289.589	10.74
26	702288.763	633392.639	12.33	70	701886.332	633299.848	32.38
27	702292.449	633380.872	31.68	71	701876.748	633330.782	22.45
28	702301.920	633350.642	19.12	72	701870.103	633352.227	13.13
29	702307.635	633332.398	21.55	73	701866.371	633364.813	27.54
30	702314.078	633311.832	15.48	74	701858.067	633391.071	12.10
31	702318.707	633297.059	15.23	75	701854.475	633402.628	22.56
32	702323.260	633282.524	18.70	76	701847.438	633424.057	29.06
33	702328.850	633264.682	12.08	77	701838.374	633451.662	3.43
34	702332.461	633253.157	15.29	78	701837.304	633454.920	18.16
35	702337.032	633238.565	10.58	79	701831.638	633472.175	13.95
36	702340.196	633228.466	1.86	80	701827.465	633485.490	31.22
37	702340.751	633226.695	9.01	81	701819.846	633515.765	6.51
38	702343.444	633218.098	14.43	82	701818.258	633522.075	26.46
39	702347.757	633204.332	11.88	83	701811.697	633547.710	31.22
40	702351.309	633192.993	11.84	84	701802.070	633577.404	50.30
41	702354.848	633181.699	14.85	85	701786.559	633625.250	18.86
42	702359.287	633167.529	15.38	86	701780.743	633643.190	15.82
43	702363.884	633152.856	15.33	87	701775.983	633658.276	22.22
44	702368.466	633138.228	16.59	88	701770.460	633679.804	73.10
Total measured surface = 329,975 m ²							
Subsector perimeter = 2,437.56 m							

According to the real situation identified in the field for the limits of the 43 real estates it is noticed, first of all, the diversity of the real estates' surface from the cadastral subsector no. 22/1.

In the present case study, the width of the real estates/parcels from the limit of the contour of the cadastral subsector D (i, i+1) ranged between a minimum of 1.86 m (D36-37) and a maximum of 73.10m (D88-1). The length of the real estates/parcels varied between 389.60 m (D1-2) and 430.91 m (D45-46).

The measured surface for the cadastral sector no. 22/1 is delimited by the perimeter length of **2,437.56 m**. The values measured on field will be registered in the chart of the cadastral sector and of the corresponding real estates

d. Establishing the measured surface on cadastral real estates

The areas of cadastral real estates were calculated in a similar manner as the area of the cadastral sector, according to *the Stereo-70 rectangular coordinates* of the points from the contour borderline of each real estate. 43 real estates were identified and determined in the cadastral subsector no. 22/1.

The destination and the present usage category of each real estate was established during the recognition phase of the land, according to the on field reality. The 43 real estates were classified as agricultural land under the usage category of arable land (A). The measured surface for the 43 real estates ranged between a minimum of 0.0773 ha (35A) and a maximum of 2.8500 ha (1A).

According to the present regulation regarding the systematic cadastral activity it is mentioned only the registration of the surfaces measured on field in the integrated cadaster and land registration system.

For the unenclosed real estates situated in the unincorporated area with the measured surface higher than the one mentioned in the documents in proof, the surface registered will be the one mentioned in the documents. This situation is applicable to the real estates that were the object of the Agricultural Real Estate Law.

For the enclosed real estates situated in the unincorporated area the registered surface is the one resulted from the measurements made, regardless of the surface mentioned in the owner's property documents. For the surface of the real estates from the old land registers, it is necessary to know the cartographic base of these documents. For Romania's territory there are cited six systems of plan rectangular coordinates for the cartographic projections used (Voinea I. *et al*, 2018).

The sum of the surfaces of the 43 real estates was equal with the surface calculated for the cadastral subsector no. 22/1.

In this case, no surface compensation was necessary as the same rectangular coordinates from the limits of the cadastral sector and of the real estates were used.

The present configuration of the borders of the real estates from the **cadastral subsector no. 22/1** pointed out the subsequent distribution of the arable land: *34 real estates with an area of less than 1 ha; 8 real estates with the area ranging between 1-2 ha and 1 real estate with the area higher than 2 ha. (table 4).*

Table 4

The surfaces' chart on cadastral sectors

No. of cadastral sector	Real estate no.	Measured surface (ha)	Usage category
22/1	1A	2.8500	Arable
	2A	0.8800	Arable
	3A	0.6300	Arable
	4A	0.7520	Arable
	5A	1.8000	Arable
	6A	1.2500	Arable
	7A	1.0592	Arable
	8A	0.2614	Arable
	9A	1.2600	Arable
	10A	0.5683	Arable
	11A	0.7410	Arable
	12A	0.1400	Arable
	13A	1.1878	Arable
	14A	0.9238	Arable
	15A	0.4961	Arable
	16A	1.0497	Arable
	17A	0.5397	Arable
	18A	0.7073	Arable
	19A	1.2100	Arable
	20A	0.4421	Arable
	21A	0.5000	Arable
	22A	0.7796	Arable
	23A	0.7194	Arable
	24A	0.5000	Arable
	25A	0.5085	Arable
	26A	1.3072	Arable
	27A	0.7895	Arable
	28A	0.8905	Arable
	29A	0.6400	Arable
	30A	0.6300	Arable
	31A	0.7737	Arable
	32A	0.5000	Arable
	33A	0.6335	Arable
	34A	0.4400	Arable
	35A	0.0773	Arable
	36A	0.3760	Arable
	37A	0.6044	Arable
	38A	0.5000	Arable
	39A	0.5000	Arable
	40A	0.6300	Arable
	41A	0.6549	Arable
	42A	0.6550	Arable
	43A	0.6397	Arable
		Total measured surface = 32.9975 ha	

e. Drawing up the technical documents for the systematic cadastral works

After concluding the systematic cadastral works for one cadastral sector the graphical and reports and tables can be drawn up, outlining the real technical and legal situation of the real estates.

According to *The Law on Cadastre and Real Estate Advertisement no. 71/1996* with the subsequent modifications and completions, the following documents are made for each cadastral sector: *cadastral plan, cadastral register of real estates and the alphabetical list of the real estates*.

The cadastral plan represents the graphical component of the technical cadastral documents drawn up for each cadastral sector. Based on these plans the general cadastral plan for the basic administrative territorial unit is drawn up.

For the *cadastral subsector no. 22/1* situated in the unincorporated area of the administrative-territorial unit of Holboca, Iasi county, the cadastral plan was made at scale 1:2000 in the national reference system.

From the content elements of the above mentioned plan there are mentioned: *the borders and the cadastral numbers of cadastral sectors and subsectors, the borders and the cadastral numbers of the real estates, the geometric grid with the side length of 200 m and others* (Figure 3).

The real estate cadastral register drawn up for each cadastral sector includes the following data: *presentation of the real estate, property/possession, incumbents / divisions / mentions/trials/interdictions and observations*.

The document referring to the *presentation of the real estate* includes: identification of the land, real estate address, cadastral number, land register number, measured surface and so on.

The primary technical data regarding the measured surface of the real estates from the *cadastral subsector no. 22/1* that will be registered in the land register were presented previously in **tables 3 and 4**.

The alphabetical list of real estates is represented by a technical document – table – where all the real estate owners from a cadastral sector and the entire administrative territorial unit, respectively, are registered. For each owner it is mentioned the property type, that is exclusively and/or joint with other individuals.

The systematic registration activity of the real estates at the level of cadastral sectors or administrative-territorial units represents, according to the present legislation, the legal base

for recording the measured surfaces in the land register.

CONCLUSIONS

The main objective for the systematic cadastre is the registration, at national level, of all real estates in the integrated cadastre and land registration system.

The systematic registration of real estates at the level of administrative territorial units ensures the legal security of the system keeping records of real estates and subsequently stimulates investments.

The technical documents corresponding to the systematic cadastre drawn up for a cadastral sector represent the legal support for registering the real estate in the land register.

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RESEARCHES ON THE MODERNIZATION OF THE CONDUCT NETWORK FROM OLD PRESSURE IRRIGATION SYSTEMS

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Abstract

The paper presents a series of concepts regarding the rehabilitation and modernization of the pipeline network in irrigation systems with sprinkling. Old spray irrigation systems in operation for about 30-40 years show wear and aging phenomena of structural components (pipes, pits, hydrants). Research on about eight sprinkler irrigation plot with pipeline networks in various exploitation concepts highlighted the complexity of the rehabilitation and upgrading process. Rehabilitation of the pipeline network is based on the type of irrigation equipment with which the irrigation plot is fitted. In the case of plots equipped with monofilament pumping stations the tertiary distribution pipeline is rehabilitated at the level of the current technique and automation equipment is introduced. The rehabilitation process must be carried out in successive stages and using modern materials and technologies of endowment and execution. Case studies developed for sprinkler irrigation plots located in Moldova are customized on the modernization directions adopted by the beneficiary: pivot spraying equipment, longitudinal displacement equipment, fixed watering equipment, etc.

Key words: pressure pipes, hydrants, dormitories, design, modernization rehabilitation

At the level of 1989, Romania had a series of irrigation systems with a technical level corresponding to the existing technologies and production materials at national and international level. Irrigation systems have contributed to the conditions of development of agricultural and horticultural crops in the climate conditions specific to Romania. Prior to 1989, a wide range of watering methods were used: watering by sprinkling, furrowing, bivalent watering, dripping, etc. Irrigation systems were formed by irrigation plotting, which was the basic unit of the system (Blidaru *et al*, 1981, Cazacu *et al*, 1982).

After 1990, most of the irrigation systems were dismantled by changing ownership of the land and by governmental decisions. Currently there is only a small number of irrigation systems built before 1989, and all are in a private system. Irrigation systems in operation show degradation processes to the construction structure and to installations serving the exploitation process. The watering method used predominantly is watering by spraying (Luca *et al*, 2016).

Irrigation is currently being applied on very small areas and uses the infrastructure built before 1990 for large irrigation systems. Small irrigation systems (mostly at irrigation plot level) with aspiration are most used in the current state. Most of these systems were built in 1970-1985.

Irrigation systems built before 1990 were water-based, pumping stations that lifted water at various elevations, transport channels, pressure or bivalent watering stations, protection and control facilities, and so on. (Blidaru *et al*, 1981, Cismaru, 2004).

Irrigation plots for sprinkler irrigation currently in operation show degradation processes in the pipeline. The pipeline network was executed between 1975 and 1982 and has an outdated service life, showing a large number of damage per year. The pipeline network has large water losses and low operating efficiency. Also, the pipeline network no longer meets the current technical requirements required by the use of modern watering equipment (Luca M., 2017).

The objective of the paper is to present a way of rehabilitation of the pipeline network under the pressure of old irrigation plots with sprinkling.

MATERIAL AND METHOD

The study and research material is represented by irrigation systems, ie irrigation plots located in the counties of Iasi and Vaslui. Irrigation systems are fed from the Prut River and are located in the meadow area on the first and second terraces (*figure 1*). The water take-off from the Prut River is made with base pumping stations (SPB) and the water is raised on terraces with pumping stations (SRP), which feed a series of

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transport and distribution channels or pipes (Luca, 2012, Luca, 2015).

Irrigation plots are fed from channels or pipelines and are equipped with SPP or single stranded pumping stations (SPPM). Irrigation plots have a pipeline network made about 40-50 years ago.

The study and research areas were as follows:

- The area is located in the system in South Soloneț, Iași County, on a terrace.
- Zone II located in the Albița Fălciu Complex Irrigation and Drainage Complex, on a plain relief (dense enclosure).



Figure 1 **Study and Research Areas: 1 - Southern Soloneț irrigation system; 2 - Complex Irrigation and Drainage Design Albița Fălciu**

For each irrigation system and irrigation plot considered in the analysis a technical documentation was carried out. For a series of irrigation plotting, technical expertise has also been carried out. Through documentation, the state of structural components was analysed on the basis of known and accessible data. The data provided by the technical expertise allowed the analysis of the current state of construction of the irrigation plotters in operation after a period of 40-50 years. The irrigation plot pipeline networks have been analysed based on data collected from the technical expertise developed over the last period of time.

The research method is used to perform technical expertise for land improvement objectives, and in particular for irrigation plots with pumping stations.

Field research has taken photos and videos. For some irrigation plots, updated topographical plans of irrigation systems in use were used. The data processing followed the methodology used in the technical and scientific analyzes developed for irrigation systems with channel and pipeline networks.

RESULTS AND DISCUSSIONS

Irrigation plots with sprinkling and mixed watering (spraying + furrows) were made in the 1970s and 1980s based on well-designed projects (Project No. 4824-R 1987). Irrigation plots in Romania were designed to water an area of 500-2500 ha. The pipeline network is fed by a SPP or by a number of monofilament pumping stations (SPPM). The pump pumping is supplied from a duct or duct belonging to the irrigation system. The irrigation plot is integrated into the irrigation system infrastructure, or can be individually designed for small areas.

The following requirements are considered when designing the sprinkler irrigation plot (Cazacu *et al*, 1982):

- constructive and functional parameters of watering equipment;
- the characteristics of the pipeline network to ensure the flows and pressures required by the number of watering equipment in operation,
- functional parameters of the pressure vessel.

Some of the irrigation plots were constructed with a single pipeline network or with a mixed pipe network, as follows:

- a. Plane with a high pressure pipeline network ($P = 7.0 - 8.0$ bar) powered by a pressure lift pump (SPP).
- b. Plot with a combined high pressure pipeline network for bivalent watering (sprinkling and furrowing) powered by a pumping station (SPP).

The pipe network for variant "a" is of a branched type and is calculated at the flows required by the watering equipment. The pipeline network is fed by a pumping and pressure station (SPP) located centrally or laterally to the plot (Project No. 4824-R 1987).

The "b" duct network is branched and consists of two rows of main and secondary pipelines for water transport to watering equipment. The pipeline network is powered by a pump and pressure boosting station (SPP) equipped with two pump sets with differential flow and pressure. Welding pumps have high flow rates and medium pressures ($P = 3.5-4.5$ bar), and those for sprinkling have lower flows and high pressures ($P = 7.0 - 8.0$ bar).

Irrigation plots with sprinkler irrigation and bivalent watering have been made in a monofilament scheme, respectively, with monofilament pumping stations fed from channels. Plots of this type were made more in the plain area and the dilapidated enclosure (Cazacu *et al*, 1982).

Bivalent irrigation plots (furrows and aspersion) were transformed after 1990 into sprinkler screens.

In most irrigation plots with sprinkling and bivalent watering, the hydromechanical installations

of the pumping stations (SPP and SPM) were rehabilitated in the first or part stage. The pipeline network was not rehabilitated at this stage (Luca, 2012, Luca, 2015).

The pipeline network of irrigation plots in operation has a long service life. The absence of maintenance and repair work and overheated lifetime have led to the degradation of structural components of pipelines, hydrotechnical structures on the grid and hydraulic installations in dormitories. In the same situation there are the irrigation channels, which feed the monofilament pumping stations from irrigation plots with sprinkling (Luca, 2016).

The analysis carried out in the Irrigation Plot SPP1b Soloneț revealed that the pipeline network is in branched form (*figure 3*) and has the following components (Luca, 2012):

- the main pipeline CP2b in length of 8955 m, made of PREMO tubes (Dn 800, Dn 600 and Dn 400) and powered by SPP1b;
- four secondary pipes (CS2, CS3, CS4 and CS5) with a total length of 8565 m, made of PREMO Dn 400, AZBO Dn (350-200) tubes and fed by CP2b;
- 38 tertiary irrigation pipelines (irrigation aerals, A30b ... A67b) with a total length of 23.128 m, made of AZBO, PVC, steel (in high pressure areas) with diameters 250 - 100 mm and fed from CS;
- hydrants for powering manually moved watering systems (mechanized move, later); the watering line is equipped with 17 sprinklers; for wet watering were used mobile watering sets type EUBA - 150;
- grid constructions: junction shafts, ventilation shafts (*figure 2*), massive anchor drainage hoods, sub-crossings etc.

The pipeline network of the SPP1b irrigation plots was commissioned in 1981.



Figure 2 **Degradation state of buildings and installations on the pipeline network of the plot Irrigation SPP1b** (Luca, 2015)

The structural degradation of the pipeline led to the occurrence of large water losses, the progressive increase in the number of damages and the increase of the energy consumption (Cismaru, 2004, Luca, 2012, Luca, 2016).

Increased operating costs and low yields of sprinkler irrigation plots required the rehabilitation of the pipeline network.

The rehabilitation of the pipeline network of the irrigation plot is based on a technical expertise and a technical project approved by a project verifier on the field of land improvement. The technical design may provide for the partial or total change of piping that forms the pipeline. The hydraulic installation in the dorms needs to be completely changed, as the service life is exceeded.

The technical design should take into account the current cropping plan in the irrigation plot to determine the irrigation norm (M), watering norm (m) and watering hydromodule (q_u).

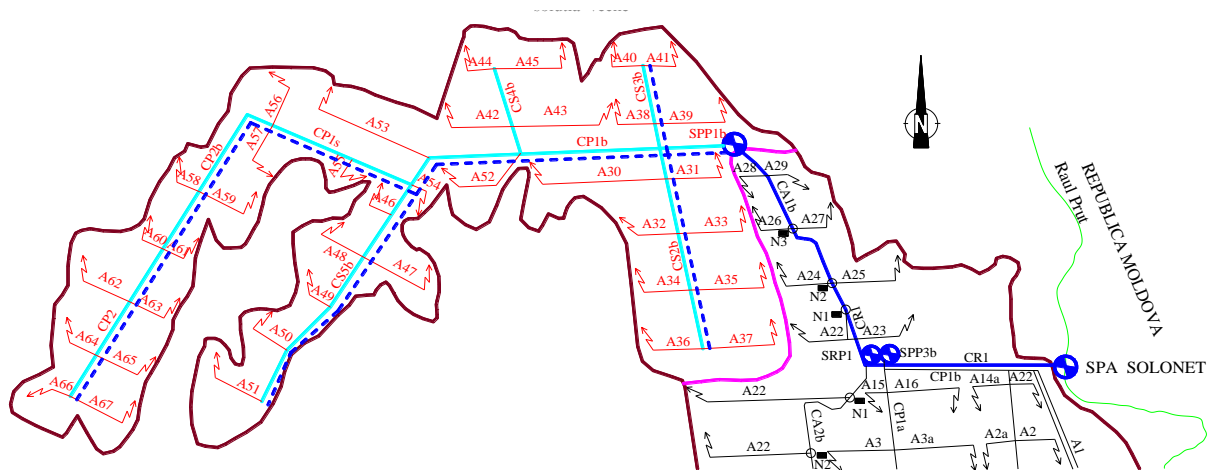


Figure 3 **Initial plot of irrigation plot SPP1b South Solonet: continuous line - main / secondary high pressure pipelines; interrupted line - main / secondary medium pressure pipes** (Luca, 2015)

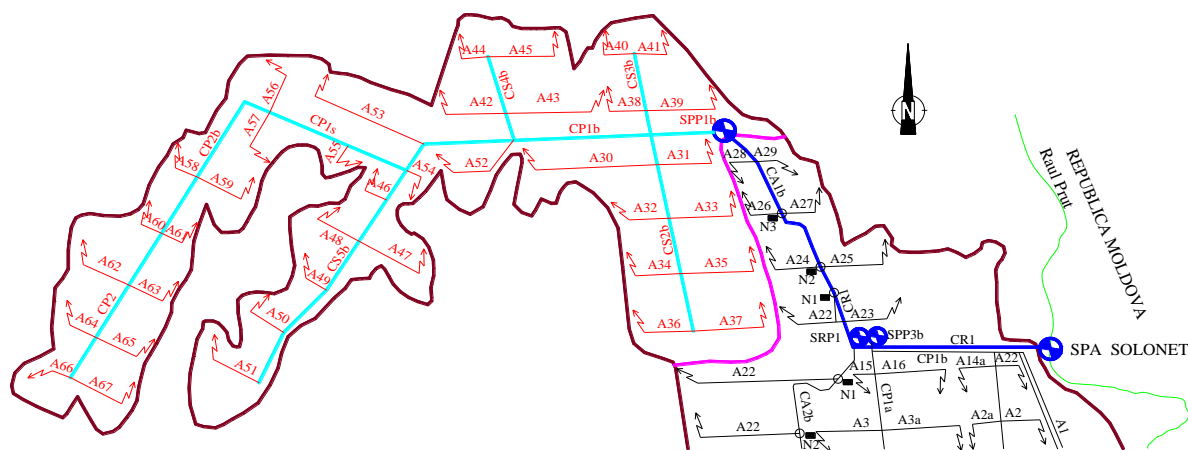


Figure 4 The new piping network layout at the SPP1b South Solonet irrigation plot

The watering hydromodule is determined by the relationship (Cazacu *et al*, 1982, Stancescu *et al*, 1985):

$$(1) \quad q_u = \frac{1000 m}{T t}$$

The relationship of the irrigation plot sizing flow calculation is as follows:

$$(2) \quad Q_{PI} = S q_{u,pond} \frac{1}{\eta_c} \frac{1}{\eta_r} \frac{24}{t}$$

care se verifică cu relația

which is verified with the relationship

$$(3) \quad Q_v = \sum Q_{av} \frac{1}{\eta_r}$$

In relations (1), (2) and (3), the notations used have the meaning: q_u is the watering hydromodule; q_{up} - medium weighted watering hydromodulus; m - watering norm; T - the number of days considered in the peak month; t - watering time per day; S - wetted area; η_c - watering efficiency in the field; η_r - network yield downstream of the pumping station; t - actual hours of operation of the watering equipment (in ec. 2); Q_v - Verification Flow Q_{av} - the sum of flows downstream of the calculated item.

Parameters of the irrigation regime considered when designing the SPP1b Solonet Nord irrigation plot are shown in Table 1.

Table 1
Parameters of irrigation regime at Plot SPP 1b

p (%)	M (m ³ /ha)	m (m ³ /ha)
50	2600	1200
80	3700	1350
p - calculation assurance		

The maximum watering hydromodulus used for the initial design of the irrigation plot resulted in corn crops and was 0.53 l/s x ha. The weighted

average net hydromodule used in the design was 0.50 l/s x ha (Luca, 2012).

The constructive modification of a pipe section or of a main and secondary pipeline within the pipeline requires a new dimension of the grid (figure 4). Changing the type of watering system requires a new dimension of the hydrants and pipelines within the network. The watering equipment used in the irrigation plot is of the "pivot" type (figure 5), which requires a complete dimensioning of the pipeline network, considering the modification of the parameters of the hydrants, changing the flows and pressures in the nodes. The new layout scheme will be designed for a high-pressure pipeline network to ensure the operation of modern sprinkler systems.



Figure 5 Pivot type watering system in the "SPP1b South Solonet" pressure irrigation plot (Luca, 2015)

In 2019, the technical documentation for the rehabilitation of a section of the main pipeline CP2b on a 970 m length, supplied by the first pumping stage (high pressure) was elaborated. The rehabilitated section is located between the SPP1b pumping station and the CS2b and CS3b secondary connection junction. The pipeline section was made of PREMO Dn 800 tubes, and by rehabilitation will be made of PEHD Dn 800, Pn 10 pipe. Changing the material over an important

length of pipe changes the hydraulic characteristic of the pipe network and implicitly parameters of the operating point of pumping station and pressurization (Q_F , H_F).

The hydraulic feature of the pipeline network on the most geodetically and hydraulically unpleasant route is determined with the relation:

$$(4) H_c = H_g + \sum M_i Q^2$$

where H_c is the hydraulic load of the pipe network; H_g - geodetic height; $\sum M_i$ - the sum of the resistance modules; Q - feed rate.

Parameters of the pumping station and pressure setting (Q_F , H_F) are determined by solving the system of equations:

$$\begin{aligned} H_c &= H_g + MQ^2 \\ H_p &= f_1(Q) \\ (5) \eta_p &= f_2(Q) \\ N_p &= f_3(Q) \\ NPSH_p &= f_4(Q) \end{aligned}$$

where H_p is the pumping height; $f_1(Q)$ - load characteristic of the pumping station; $f_2(Q)$ - pumping station efficiency characteristic; $f_3(Q)$ - pumping station power characteristic; $f_4(Q)$ - cavitations characteristic of the pumping station.

The absence of total rehabilitation of the pipeline network leads to increased water losses on the old pipeline sections, which have an overheated exploitation period. The absence of rehabilitation of the pipes on the pipeline network, construction and hydraulic installations leads to an increase in the number of damages and consequently the loss of water.

A case study has been prepared for a sprinkler irrigation plot located in "Albița - Fălciu Complex Planting" Vaslui County. The irrigation plot "16 Berezeni" is located at the southern boundary of Satu Nou - Berezeni village, Berezeni commune, Vaslui County.

The total area irrigated within the plot is 986 ha. The irrigation system was designed by I.S.P.I.F. Bucharest in 1977 and was executed between 1977 and 1980.

The analysis carried out at "Plot 16 Berezeni" from the Albița - Fălciu Complex Irrigation and Drainage System (figure 6) revealed the totally unsatisfactory state of the constructive structure of the pipeline network under pressure (Luca M., 2015).



Figure 6 **Layout scheme of the of the pressure irrigation plot „Plot 16 Berezeni”** (Luca, 2015)

The large number of damages required partial rehabilitation of some pipe sections. The damage was also intensified by the failure of the hydraulic shock protection system. Pipes made from asbestos have been degraded by the hydraulic shock produced during the exploitation process (figure 7) (Luca, 2015).



Figure 7 **Condition of degradation of asbestos pipes in the structure of the pipeline network of "Berezeni Plot 16"** (Luca, 2015)

The pumping station of the irrigation plot „16 Berezeni” was partially rehabilitated at the level of the hydro-mechanical equipment in the last period of time. The pipeline network consists of the following components (Luca, 2015):

- main pipeline (CP1) made of PREMO Dn 800 to 400, Pn 10 tubes and Dn 350, Pn 10 asbestos, 2772 m long;
 - tertiary pipes (irrigation antennas, 12 pieces) in total length of 21.248 m made of asbestos-cement tubes with Dn 350 ... 125, Pn 10 and connected to CP1; Dn 100 type normal and drainage hydrants are placed on the pipes;
 - network construction: derivation dams, drainage and ventilation shafts, massive anchorages, etc.
- In order to limit the number of damages on the

main pipeline, a rehabilitation project for a 1770 m long section was prepared, where PREMO pipes with PRHD pipe were replaced. Also rehabilitated sections from the tertiary pipes in 3935 m length of asbestos pipe, which was replaced with PEHD pipe (figure 8).



Figure 8 **Rehabilitation of the ventilation chimney on the main pipe CP1 in "Berezeni Plot 16"** (Luca, 2015)

The problem of water losses in pipelines under pressure (6.0 to 8.0 bars) in the irrigation plot must be considered in the rehabilitation process. Water losses influence the efficiency of the pipeline network and, implicitly, the yield of the irrigation plot.

The efficiency of the pipeline network for the current exploitation case can be determined with the relationship (Stancescu et al, 1985):

$$(6) \quad \eta_c = \frac{\alpha * Q_{inst} * T_1 - \sum p_i * T}{\alpha * Q_{inst} * T_1} * 100 [\%]$$

where: α is the ratio between the average daily flow rate and the flow rate installed at the SPP; Q_{inst} - installed SPP debit; $\sum p_i$ - sum of the losses during the irrigation period, determined as a percentage of the total volume of pumped water; T_1 - number of days of operation of SPP; T - the duration of the irrigation campaign in which the network was filled with water.

The efficiency of the pipeline network is not currently assessed by the irrigation plots.

The rehabilitation and upgrading of the pipeline network of the irrigation plots has to be done by redesigning the pipeline network by adopting a new concept of a layout scheme that considers the functional parameters of the modern watering installations.

CONCLUSIONS

1. Irrigation plots with sprinkling are the most often rehabilitated and upgraded components

of the old irrigation systems that are still in operation in Romania.

2. The irrigation plot pipeline network must be rehabilitated in view of exceeding the operating life of most components (pipelines, chimneys, hydraulic installations, etc.) and large water losses occurring in the exploitation process.

3. The use of modern sprinkler systems in irrigation plotting requires the adoption of a new concept of pipeline network and the redimensioning of pipelines according to new flow and pressure requirements in the network nodes.

4. The rehabilitation of the pipeline network of the irrigation plots must be carried out in a complex way at the level of the current technique with the introduction of the monitoring and automation system of the exploitation process.

5. The design of the new pipeline network of the irrigation plot must be correlated with the characteristics of the pumping station and the pressure relief station (operating point parameters) to obtain the optimal flow and pressure when operating the operation process.

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RESEARCH ON THE INFLUENCE OF HYDROGELS STOCKOSORB AND TERRACOTTEM ON THE DEVELOPMENT OF SOME AGRICULTURAL PLANTS SPECIES

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Abstract:

Amplification of the greenhouse effect has increased the conditions of abiotic stress on plant growth, mainly by eroding large areas of land and reducing freshwater reserves. A remedy for increasing the efficiency of these lands and decreasing the irrigation is the incorporation in their structure of ecological and biodegradable hydrogels. Hydrogels are highly flexible, inflatable materials composed of polymers which have the property of absorbing and retaining a large amount of water, subsequently releasing them into several absorption–release cycles. By their specific characteristics, they can lead to : stimulating water retention capacity near seeds or roots, reducing the risk of water loss by leaching or evaporation, increasing soil permeability, reducing soil degradation and implicitly increasing quantitative and qualitative productivity. Due to these properties, hydrogels are finding a growing number of applications in both agriculture and horticulture, by being very useful in conditioning and fertilizing soils and by also having a stimulating effect on : the proper growth of agricultural plants, the physiological processes and development .

Based on these observations, the influence of 2 types of hydrogels was observed, namely: Stockosorb and TerraCottem on the state of these types of vegetation: wheat, maize and sunflower. The result of this research has shown a increased influence and efficiency of about 11%- 16% on the chosen plants that are treated with Terracottem compared to that of Stockosorb.

Key words: Hydrogel, Stockosorb, TerraCottem, hydrophilic polymer, water retention

In the last decades, the drought and related phenomena, such as aridization and desertification, represent, after pollution, the second major problem faced by mankind.

Agriculture is based on the existence of a sustainable and renewable resource base such as water and soil. For this purpose, new specialists develop new methods of irrigated land protection and the most efficient use of water resources. The relationship between plant genetics, water consumption, practices used and local environmental conditions is the quantitative and qualitative basis of production.

The hydrogel polymer compound seems to be extremely effective to be used as a soil conditioner in agricultural sector, to boost crop tolerance and growth in a sandy or lightweight gravel substrate. The hydrogel polymer has been established as a soil conditioner to reduce soil water loss and increase crop yield.(Ovalessa M.A. *et al*, 2017).

Hydrogel polymers have the ability to absorb water and increase their original weight a hundred times within a short period of time and

desorb the absorbed water under stress condition. (Zhang J. *et al*, 2006). Thus, the hydrogel increases efficient water consumption, decreasing irrigation costs and increasing irrigation intervals, also implements the soil's water holding capacity and soil porosity, providing plants with eventual moisture and nutrients as well as enhancing plant viability and ventilation and root development which provides a conducive atmosphere for better growth of plants and finally increases crop yield.

Applications of hydrogels are closely related to soil type, geographical area, and plant species.

Thus, this paper aims to test two categories of polyacrylamide hydrogels such as Stockosorb and TerraCottem to track the influence and their effectiveness on the state of vegetation in agricultural plants like: wheat, maize and sunflower. For these crops the next hybrids are used: Mirastar, PO412 and Justin.

TerraCottem Complement (*figure 1*) has been specially formulated for applications in agriculture. This replenishes the soil components that have been consumed by the plants during the growing season. Due to its application of nutrient

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and water holding capacity of soils and growing medium is kept in optimal conditions. In its composition the following components that stimulate the growth of plants are included: 1. *growth precursors* that activate the elongation and differentiation of the cells in the root and lead to leaf development and an increase in biomass production - roots thus grow faster at greater depths; 2. *acrylamide* cross-linked polymers of acrylamide and acrylic acid neutralized by potassium and ammonium salts absorb and store water that is normally lost at evaporation, reducing the volume and frequency of irrigation need by up to 50% (Tirthankar J. *et al*, 2001). This water is then kept at the disposal of the plant that accesses the water accumulated as needed by the root wires, keeping the water in the root area for a longer period of time; 3. *fertilizers* provide balanced plant nutrition based on macro and microelements.



Figure 1 **Structure of TerraCottem**

TerraCottem's carrier materials are selected for their chemo-physical properties (CEC, WRC, etc.) and their characteristics which allow homogeneous distribution of all components.

The Stockosorb (*figure 2*) is a soil conditioner specially designed and developed for water and nutrient retention and release in substrates and soils. Upon contact with water, it swells quickly, creating a hydrogel by Stockosorb absorbing and retaining large quantities of plant available water. Fertilizer leaching can thus be reduced. During the soil drying process, both water and water-soluble nutrients are released to the plant in a uniform manner.



Figure 2 **Structure of hydrogel Stockosorb**

Is a highly cross-linked water insoluble superabsorbent anionic polymer that is partially neutralized with potassium. Stockosorb 500 is a copolymer containing acrylic acid, acrylamide and potassium and Stockosorb 660 is a homo-polymer based on acrylic acid potassium. This hydrogel absorbing more than 216 times its original weight

in water, and then releases it on demand from plants. Stockosorb also binds and releases water-soluble nutrients, creating a healthy micro-environment.

Stockosorb also strongly resists soil pressure at high soil depth without losing its swelling capacity. Performs its wetting/drying cycles over a long period of time, maintaining its very high water swelling and releasing capacity even against soil pressure.

MATERIAL AND METHOD

The experiments were performed in the field conditions on 8 experimental plots with 1 m² each, in which 3 variants were placed: V1 (control untreated –without treatment), V2 (treated with 20 kg/ha Stockosorb) and V3 (treated with 20 kg/ha TerraCottem). The seeds were planted at 1.04.2019.

Inflation of hydrogels was followed using facilities designed on the principle of operation of the Dogatkin apparatus. The burial of the hydrogels in the soil was made at a depth of 8-15 cm. The soil used had an average organic content of 71.25% and nutrients (values reported relative to the dry substance): N-NO₃ = 4.35·10⁻³ %, N-NH₄ = 1.85·10⁻³ %, P₂O₅ = 1.45·10⁻³ %, K₂O = 34.25·10⁻³ %, CaO = 117·10⁻³ %, MgO = 42.35·10⁻³ %. The cultivated agricultural plants are: wheat (*Triticum aestivum*), maize (*Zea mays*) and sunflower (*Helianthus annuus*).

The vegetation state of plants grown in the soil-hydrogel mix compared to the control sample (plants grown on the same soil type but without a hydrogel) have been observed for 4-6 months, depending on their vegetation period. After this time, the plants were removed and then measured and weighed.

RESULTS AND DISCUSSIONS

Plant growth observations were made throughout their vegetation period between April and September 2019. It was found that plants placed on the hydrogel-embedded lots developed better than the control plants on the non-hydrogel plot. There were differences in height, number of leaves, seeds, and beans differences due to a better nutrition regime for plants tested on hydrogel lots. Although water quantities and watering ranges were the same for all plants, the presence of hydrogels in the soil determined that retained water, at a higher proportion and longer intervals, would help to improve the growth of plants on these lots compared to the blank without hydrogels.

The evolution of plants is influenced by both the swelling behavior of the hydrogels and the

nature of the polymer included. The average height of plants is directly proportional to soil moisture. There are statistically significant differences between the treated variants with hydrogels and the witness variant. Therefore, the sizes of the plants were higher in plants treated with hydrogels TerraCottem and Stockosorb.

In the study period, the plants of the TerraCottem hydrogel group were best developed (because includes more nutrients), then those on the Stockosorb which did not allow the development of spectacular plants, even if the conditions were the same. It also has a higher water retention capacity of about 13% compared to Stockosorb hydrogel.

Table 1

Evolution of the start of vegetation and ripening for the 3 species of plants

Agricultural Plants	Date of vegetation start (emergence)			Date of ripening start		
	Control lot (V1)	Lot with Stockosorb (V2)	Lot with TerraCottem (V3)	Control lot (V1)	Lot with Stockosorb (V2)	Lot with TerraCottem (V3)
wheat	09.04.2019	08.04.2019	06.04.2019	04.07.2019	27.06.2019	22.06.2019
maize	07.04.2019	06.04.2019	05.04.2019	13.09.2019	03.09.2019	27.08.2019
sunflower	15.04.2019	12.04.2019	10.04.2019	06.08.2019	24.07.2019	15.07.2019

In table 1 it is observed for wheat culture: begins to rise around 9.04.2019 on the control lot (V1), on 8.04.2019 on the lot with Stockosorb and around 6.04.2019 for the TerraCottem lot and dates of ripening start are: around 4.07.2019 for (V1), 27.06.2019 for (V2) and 22.06.2019 (V3).

The next culture, as the moment of emergence, is represented by maize, around 15.04.2019 on the witness lot, on 12.04.2019 the lot with Stockosorb and around 10.04.2019 for the TerraCottem lot, and dates of ripening start are: around 13.09.2019, 3.09.2019 for (V2) and 27.08.2019 (V3). For the sunflower culture, as the moment of emergence begins around 15.04.2019 on the witness lot, on 12.04.2019 the lot with Stockosorb and around 10.04.2019 for the TerraCottem lot, and dates of ripening start are: around 6.08.2019, 24.07.2019 for (V2) and 15.07.2019 (V3).

The most convenient are the variants with TerraCottem and Stockosorb. During the vegetation, the observations and determinations were achieved for: sunrise, flowering, maturity and density of the selected crop. In figure 3 is represented the development of wheat culture in the year of study 2019.

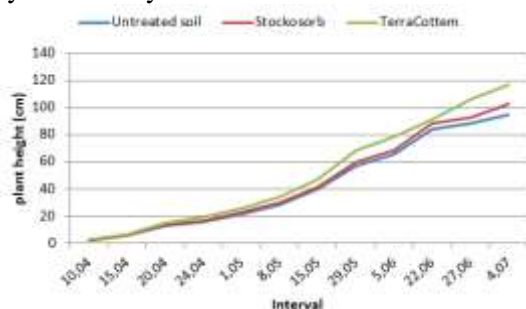


Figure 3 The development of the wheat culture in the year of study 2019

For wheat culture, the maximum height is reached on 4.07.2019, a maximum of 116.9 cm in

the presence of TerraCottem, 102.5 cm the one treated with Stockosorb and 95.2 cm on the control lot. Table no.2 shows the characteristics of wheat culture. The raw protein content had values of between 13.7 % for the control lot and 14.50% for the lot with TerraCottem, and the maximum production was 7087 kg/ha.

Table 2

Characteristics of wheat culture

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with TerraCottem(V3)
Production (kg/ha)	6125	6650	7087
Mass of 1000 seeds (g)	41	45	49
Hectolitre mass kg/hl	72	74	79
Raw Protein %	13.7	14.10	14.50

In figure 4 is represented the development of the maize culture in the year of study 2019.

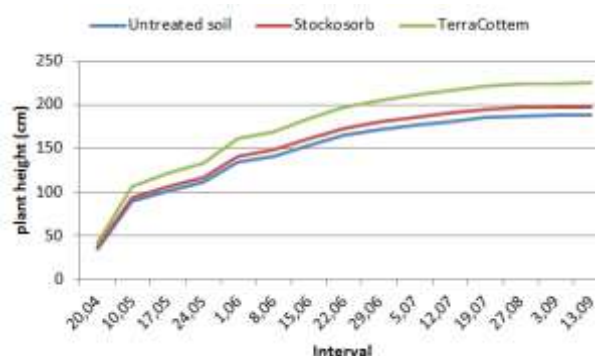


Figure 4 The development of the maize culture in the year of study 2019

For maize culture, the maximum height is reached on 13.09.2019, a maximum of 225.3 cm in the presence of TerraCottem, 197.6 cm the one treated with Stockosorb and 188.2 cm on the control lot. In table 3 it is observed the

characteristics of maize culture. For experiments on the lot with TerraCottem have obtained very favorable values for: production -16045 kg/ha, starch content -93.73% and protein content -9.61 (g/100 g dry substance).

Table 3

Characteristics of maize culture

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem(V3)
Production(kg/ha)	15 150	15 650	16 045
Starch content (%)	75.78	86.85	93.73
Protein content (g/100gdry sub)	8.93	9.42	9.61

In figure 5 is represented the development of the sunflower culture in the year of study 2019.

For sunflower culture, the maximum height is reached on 6.08.2019, a maximum of 201.6 cm in the presence of TerraCottem, 176.8 cm the one treated with Stockosorb and 168.4 cm on the control lot.

Average values of sunflower seed production and morphophysiological characters tested are summarized in table 4.

Table 4

Average values of sunflower seed production and morphophysiological characters tested

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem (V3)
Seed production (kg/ha)	2980	3240	3560
Weigh of seeds per calatidium (g)	149.15	161.32	178.22
Percent dry seeds (%)	3.8	3.2	2.1
Mass of 1000 seeds (g)	74	81	89
Hectolitic mass	36	37.5	39
Oil content in seeds (%)	51.8	54.6	57.8
Number of days from sowing/ physiological maturity	128	127	125
Heigh of the plants (cm)	168.4	176.8	201.6
Thicknees of the stem (cm) -1 m from the ground	2.8	3.2	3.9
Diameter calatidium (cm)	30.35	32.75	36.15
Efficiency of the leaf surface (mg dry subst/cm ²)	1.45	1.61	1.74

CONCLUSIONS

The characteristics of hydrogels influence the development of plants by swelling water holding capacity in soil, it also provides a conducive atmosphere for the better growth of roots.

It is found that in the presence of TerraCottem the plants germinate and grow faster compared to the Stockosorb hydrogel and the control group without hydrogels.

The production of plants on the experimental lot with Teracottem is about 13% higher compared to the one on the Stockosorb hydrogel lot and about 20% higher than on the control lot.

Future research take into consideration the application of polymers in different agro-

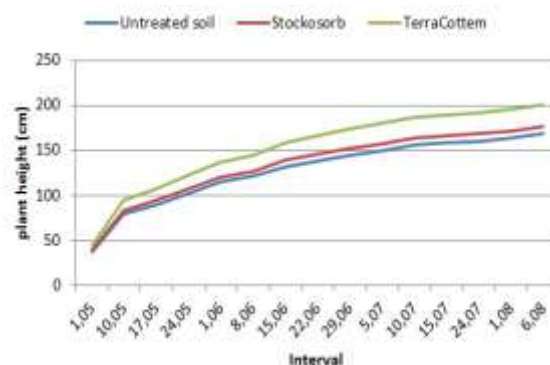


Figure 5 The development of the sunflower culture in the year of study 2019

From the values mentioned above, the advantages of incorporating the Teracottem into the soil are obvious, which helps: obtaining a seed production of about 3560 kg/ha, developing a diameter calatidium of up to 36.15 cm, oil content in seeds higher than 57.8% or a percentage of dry seeds of only 2.1%..

ecological conditions, soil types, as well as the prolonged effect of the polymer on subsequent rotational crops.

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AN AGROECOLOGICAL APPROACH FOR DANUBE DELTA BIOSPHERE RESERVE: STRUCTURE OF EDAPHIC MESOFAUNA COMMUNITY IN AGRICULTURAL CROPS AND THE SURROUNDINGS NATURAL ECOSYSTEMS

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Abstract

As part of a larger research developed within the Core Program and dedicated to the natural and anthropogenic ecosystems of the Danube Delta Biosphere Reserve, this study aims to investigate the edaphic mesofauna in several agricultural ecosystems and in the meadows of their vicinity. In both natural and anthropogenic ecosystems, edaphic mesofauna in interrelation with soil microorganisms actively participates in the processes of degradation of vegetal necromass. The comparative analysis of edaphic microarthropod communities indicates that agroecosystems do not provide favorable conditions for their development, with the densities being the smallest, while higher values have been noted in meadows, especially in non-grazed ones. In both agroecosystems and meadows, the mites dominate the rest of the microarthropods. Among the mites, the predominance of thrombidiforms is observed both in meadows (42% and 54% respectively) and in most agricultural crops (38-89%). In non-grazed meadows and in some agricultural crops, oribatids are predominant (39% - 66%). Among thrombidiforms, tydeid - mites with a diversified trophic regime - are common to crops and meadows. They were found in most of the samples from investigated agroecosystems and also in meadows, but with great representation only in the last category.

The ratio of the main detritomicrofitophagous groups (oribatids / collembolans), a good bioindicator of the quality and humification stage of an organic substrate, was superior in most of the examined plots being subunit in only 23% of cultures and in a pasture. On the basis of all these findings it can be appreciated that humification is predominant, and the nutrient cycle is slower in almost all the considered plots. The study also reveals that the influence of agroecosystems on neighboring natural ecosystems at the level of edaphic mesofauna communities has not been confirmed.

Key words: soil, microarthropods, agroecosystems, meadows

In Europe Danube Delta Biosphere Reserve represents an important centre for biodiversity and a natural genetic bank with a great value for global natural heritage. Some of the natural resources especially grasslands, are sometimes over-exploited as a consequence of the human activities which are not in harmony with the environment.

An old occupation of the local population within the DDBR is agriculture. The traditional agriculture, developed on a few hectares plot generally concerned monoculture; sanitary treatments and culture rotation are not usually used, results being generally weak, covering only the family needs. On the other hand, currently, on an area of about 35,000 ha intensive agriculture is practiced and chemical fertilizers and plant protection treatments are used, facts that have a significant negative impact on the delta ecosystems and could radically alter them.

Totally, on the territory of the DDBR, the

agricultural lands represent 12.9%, the largest share being arable land (63%), followed by natural meadows (36.7%). Vines and orchards occupy insignificant areas on the private lands of the inhabitants. The largest areas of arable land are cultivated with wheat, corn, sunflower, rape, fodder crops.

This study is dedicated to the knowledge of the structural features of the edaphic microarthropods from agro-ecosystems and surrounding meadows from the DDBR territory in order to establish a linkage between soil usage, stand conditions and anthropogenic pressure.

MATERIAL AND METHOD

The research was conducted in a series of crops and grasslands, as follows: Beștepe (corn, sun flower, rape, meadow), Murighiol (barley, sun flower, alfalfa, meadow), Plopu (wheat, meadow),

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Sarinasuf (alfalfa, sun flower, meadow, wheat), Sarichioi (green peas). Samples were taken in 2017 and 2018, as in table 1.

For each of these stations it has been proceeded at a serial prelevation of the soil samples, each sample with a surface of 100 cm² - 85 samples in all.

Extraction of the microarthropods from the eighty-five samples was made by Tullgren – Berlese method, in the Balogh manner. The assessment of the biodiversity of the edaphic microarthropods is done by inventory and analyse the mites of the Parasitiformes (Mesostigmata order) and the Acariformes (orders Trombidiformes and Sarcoptiformes - Oribatida subdivision and Astigmatina cohort), an order belonging to the class Entognatha (Collembola) and insects as a whole and other edaphic microarthropods. Then, for the faunistic material subjected to microscopic study, the abundance of each group was recorded sample by sample and the average abundance in individuals/100 cm² was calculated. In the case of

Trombidiformes, the representation (R%) of each family (Müller *et al*, 1978), i.e. the percentage of individuals belonging to a certain family, found in each plot, relative to the total number of individuals recorded in a series of investigated plots, was calculated.

RESULTS AND DISCUSSIONS

Average density of edaphic microarthropods varies in agro-ecosystems between 3.4 individuals/100 cm² (Plopu - wheat crop) and 141.4 individuals/100 cm² (Beștepe - rape crop) (*table 1*). In the samples taken one year later from the wheat culture from Plopu the densities were approximately 15 times higher while at Sarinasuf at the same type of culture the densities are almost 21 times higher (*table 2*)

Table 1

Locality	Coordinates		Type of ecosystem			Code		Collecting data
	N	E						
Beștepe	45°05'15"	29°02'26.76"	anthropic	corn	annual crop	1	c	12 th of July 2018
				sun flower			sf	
				rape			r	
			natural	meadow		mw		
Murighiol	45°01'54.52"	29°08'11.56"	anthropic	barley	annual crop	2	b	6 th of June 2017
				sun flower			sf	13 th of July 2018
				alfalfa			a	
			natural	meadow			mw	
Plopu	45°01'23.47"	29°06'33.63"	anthropic	wheat	annual crop	3	w	7 th of June 2017
				wheat			w	13 th of July 2018
			natural	meadow			mw	
Sarinasuf	45°0.5'50.59"	29°04'53.34"	anthropic	alfalfa	perennial crop	4	a	6 th of June 2017
				sun flower	annual crop		sf	13 th of July 2018
				alfalfa	perennial crop		a	
			natural	meadow			mw	
			anthropic	wheat	annual crop		w	
Sarichioi	44°55'35.39"	28°50'13.47"		peas		5	p	6 th of June2017

In the period between 2005-2016 some researches concerning crops and meadows were done (Călugăr A., 2005, 2006, 2007, 2010; Călugăr A., Ivan O., 2009; Acatrinei A. L., Călugăr A., 2010; Călugăr A. et colab., 2015; Călugăr A., Ivan O., 2018); among these some were done in wet meadows from Prut riverside and some in saline ones from the Danube Delta Biosphere Reserve (Călugăr A., 2005, 2010; Călugăr A., Ivan O., 2018).

Comparing the results from this work with those from a series of annual crops, investigated from the lower section of Prut meadow, we noticed that the density of soil microarthropods from wheat

crop is approximately the same as at Plopu counted from the samples taken in 2018 (Constantineanu I. *et al*, 2010).

In the meadows average density of edaphic microarthropods varies between 217,8-471,8 individuals/100 cm², values which are 3-139 times higher than those in agricultural ecosystems. The higher value was obtained for the meadow with an integrated system of protection (Murighiol) and the lowest value was observed in a grazed meadow (Sarinasuf). The values are up to 4.6 times higher than that registered in meadows from the lower

section of Prut (Călugăr A., 2005, Constantineanu I. *et al*, 2010).

From qualitative point of view, without exception, in all investigated plots we can see a numerical dominance of mites compared with insects, in percentages ranging from 38% to 96% of the total effectiveness of mesofauna (*table 1*).

Crossley D. A. *et al*, 1982 stipulated that in agricultural ecosystems the populations of oribatid

mites declined while those of predatory mites, such as gamasids can be favored by the conversion to field cultivation. Despite this consideration, results of the present research have shown that both in crops and in the meadows oribatids (39-80%) or trombidiform mites (38-89%) prevail.

Table 2

Average density of the edaphic microarthropods from the analyzed agroecosystems

Taxa		Locality		1				2				3			4					5
				c	sf	r	mw	b	sf	a	mw	w	w	mw	a	sf	a	w	mw	p
		Culture		Year		2018				2017	2018			2017	2018		2017		2018	
Mesostigmata	1.2					0.2	15.4	73	11.2	5.6	2.6	139.4	0	6.2	2.4	3.2	2.8	4.2	4.8	8.8
Trombidiformes		9.8	4.6	6	22	33.4	2.2	4.2	80.6	2	8	51.4	19.6	12.6	15.6	1.8	91.4	5		
Sarcoptiformes	Oribatida	1.2	0.4	26.8	173.4	19	8.8	3.2	157.4	0.2	12.2	40	24.4	31.6	28	27.4	48.2	3		
	Astigmatina	0	0	79.6	0.4	5.4	2.4	1.2	5.2	0.6	3	1.2	15.8	1	0.6	0	1.2	3.4		
Total Acari		12.2	5.2	127.8	268.8	69	19	11.2	382.6	2.8	29.4	95	63	48	48.4	34	149.6	11.6		
Entognatha		2.6	0.4	11.2	57.2	2.2	8.4	5.4	61.2	0.2	16	3.6	5	3.2	9	17.6	54.6	0.2		
Insecta		0.2	0.8	2.2	77	6.5	0.4	5.4	28	0.4	5	153	9.8	0.8	3.4	17.8	13.6	0.2		
Alte grupe		0	0	0.2	1.4	0	0.2	0	0	0	0.4	1.6	0	0.6	1	0.4	0.4	0		
TOTAL		15	6.4	141.4	404.4	77.7	28	22	471.8	3.4	50.4	253.2	77.8	52.6	61.8	69.8	217.8	12		

Mites from Mesostigmata have the biggest abundance only in the meadow from Murighiol, with 36% of total mites, oribatid mites also owning the majority with 41% of the total of mites; Murighiol is also the only one plot where in the samples were found uropodid mites (only 18 individuals). Their presence, even in a small number, shows a less modified environment (Athias-Binche 1981, Karg 1989, Gulvik 2007).

In 35% of the investigated plots trombidiform mites have the majority with percentages which reach 33- 80%. Astigmatina mites which are stimulated by anaerobic environments rich in nitrogenous substances were identified, only with three exceptions (corn and sun flower from Beștepe, wheat from Sarinasuf), in all analyzed soils, with percentages between 0.2 - 62% of total mites, at Beștepe in the rape culture holding the supremacy (*table 1*).

A bioindicator of the quality and stage of humification of an organic substrate - the Oribatida/ collembolans ratio (Huțu *et al*, 1992) was also calculated. This ratio was subunit in four

ecosystems: corn from Beștepe, alfalfa from Murighiol, wheat from Plopu and the natural meadow from Sarinasuf; in the last two cases the obtained values are only slightly under-unit. In the other analyzed ecosystems the ratio Oribatida/collembolans is supraunit, the biggest value being at sun flower from Sarinasuf (*table 1*). These results have shown that humification is prevalent in the majority of the studied plots both crops and meadows; the nutrient cycling is slow and the soil quality is improved ensuring an optimal functioning of those ecosystems.

In the case of *Trombidiformes*, a varied group from the trophic point of view (Krantz & Walter, 2009), a family analysis was performed. A total of 1825 individuals from 22 families were sampled and identified. Analysis of the trophic regime revealed that trombidiform mites which have a zoophagous diet represent approximately 50%, those with microfitophagous and polyphagous trophic regime approximately 18%, respectively 23%, and only two families have a phytophagous diet.

Many studies certify that a greater environmental heterogeneity below ground, provided by the diversity of plant roots, would ensure a greater edaphic biological diversity and the existence of all the functional groups. In this way essential soil functions such as the nutrients cycling and carbon mineralization are expressed, increasing fertility and improving the soil structure (Peredo *et al.*, 2009). This observation is confirmed by our researches, into the samples extracted from meadows, where plants are very diverse, a more diverse spectrum of trombidiform mites, illustrated by a bigger number of families was remarked. As regards crops we noticed in a perennial culture of alfalfa (Sarinasuf) the highest biodiversity, the same






as in the meadow from Beștepe. In the case of annual cultures the highest biodiversity was observed for the sun flower culture from Sarinasuf; here the number of the trombidiform families is comparable with alfalfa from Sarinasuf and the meadow from Plopu. At the alfalfa crop from Murighiol which was in the first year of vegetation and was mowed at the time of sampling, the number of the identified trombidiform families was two times lower (*table 3*), therefore this anthropogenic activity influencing the community.

From the qualitative point of view, on the basis of the values of representation index, one can notice that mites from Tydeidae are common to majority of crops and meadows (*table 3*).

Table 3

Representation (%) of the trombidiform families in the studied ecosystems

Trophic regime	Family	1				2				3			4					5
		2018				2017	2018			2017	2018		2017		2018			2017
		c	sf	r	mw	b	sf	a	mw	w	w	mw	a	sf	a	mw	w	p
P	<i>Stigmaeidae</i>																	
	<i>Rhagidiidae</i>																	
	<i>Bdellidae</i>																	
	<i>Erythraeidae</i>																	
	<i>Cunaxidae</i>																	
	<i>Trombidiidae</i>																	
	<i>Caligonellidae</i>																	
	<i>Anystidae</i>																	
	<i>Teneriffiidae</i>																	
	<i>Ereynetidae</i>																	
	<i>Paratydeidae</i>																	
M	<i>Nanorchestidae</i>																	
	<i>Tarsonemidae</i>																	
	<i>Scutacaridae</i>																	
	<i>Pygmephoridae</i>																	
D	<i>Eupodidae</i>																	
	<i>Tydeidae</i>																	
	<i>Pachygnatidae</i>																	
	<i>Cryptognathidae</i>																	
	<i>Raphignathidae</i>																	
Ph	<i>Tetranychidae</i>																	
	<i>Eryophiidae</i>																	

Legend: c, sf, r, a, w, mw - types of crops as in § Material and method; P - predator, M - microphytophagous; D - diverse (detritomicrophytophagous, predator, microphytophagous, algivore); Ph - phytophagous;  - under 1%,  - 1-25%,  - 25-50%,  - 50-100%,  - 100%

Thus, they were identified in 88% of the considered plots, being found in most of the samples from investigated agro-ecosystems and also in all meadows, but with greater values of representation in the last category, especially at Sarinasuf (62%). Likewise, tydeid mites, eupodids,

with a diverse trophic regime were found in the majority of ecosystems meaning 76% of the plots. The predator cunaxids were identified in 70% of plots; both tydeid and cunaxid mites have the biggest values of representance in meadows (both with an alike value of representation - 43%, respectively 42%). At the opposite pole, with a

small representation or even absent in some meadows, but identified also in lots of plots - 88% are the microphytophagous mites from Nanorchestidae (*table 3*).

The families *Stigmaeidae*, *Erythraeidae*, *Tarsonemidae*, *Bdellidae* are also present in lots of habitats (58-64%). Among these, stigmaeid mites, with a zoophagous trophic regime, are distinguished by a large representation in meadows, especially at Murighiol (52%) (*table 3*).

On the other hand, it is worth noting the presence of some families in only two or three ecosystems but with a high percentage of representation in a certain type of culture (for example, *Anystidae* in sun flower and Tetranychidae in alfalfa) or in one grassland (*Caligonellidae*, *Cryptognathidae*). Some families were found only in one plot from a crop or a meadow (*Teneriffidae*, *Ereynetidae*, *Raphignathidae*, *Eryophiidae*) (*table 3*).

On the base of a high value of representance index (50.1-100%) only in the crops one could considered characteristics for this kind of ecosystems the following families: *Ereynetidae* and *Pygmephoridae* (barley), *Anystidae* (sun flower), *Scutacaridae* (rape), *Raphignathidae* (alfalfa). Based on the same principle, could be considered characteristic for the meadows four families: *Stigmaeidae*, *Caligonellidae*, *Eupodidae*, *Cryptognathidae* (*table 3*). Mites from *Tetranychidae* and *Eryophiidae* are pest mites who are feeding by sucking up the liquid contents from plant cells, being collected in a small number of individuals together with the plants that accompanied the soil samples from the respective crops. So, even with a big percentage of representation they aren't characteristic for a certain culture/meadow (*table 3*).

CONCLUSIONS

Habitat type with the plot peculiarities was the main factor which influences both quantitative and qualitative structure - taxonomic and trophic structure of the communities. Also, climatic conditions that occur in the sampling period influenced edaphic mesofauna. In the meadows average density of edaphic microarthropods is higher than that in agricultural ecosystems. In the grazed meadows the densities are lower than in the non - grazed ones.

Within edaphic mesofauna of the investigated agro-ecosystems, mites are dominant compared with insects; among mites, either trombidiforms or oribatids hold the majority. In non-grazed meadows

and in some agricultural crops, oribatids are predominant.

An analysis of trombidiform mites by trophic regime shows that the mites with zoophagous trophic regime are predominant.

An overview on the biodiversity of trombidiforms in the two categories of ecosystems - crops and meadows revealed that certain families are characteristics for the first category and some for the second. For crops five families of trombidiforms could be considered characteristic: *Ereynetidae* and *Pygmephoridae* (barley), *Anystidae* (sun flower), *Scutacaridae* (rape), *Raphignathidae* (alfalfa). For meadows, four families could be considered characteristic: *Stigmaeidae*, *Caligonellidae*, *Eupodidae*, *Cryptognathidae*. More researches are necessary to verify the findings, especially those referring to characteristics families for an ecosystem category, because these findings could be influenced only by the conditions from the sampling moments.

Tydeid mites - are common to crops and meadows with a great representation only in the last category; even so, these mites could be considered with large ecological valence, additionally considering that they have also a diversified trophic regime.

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INFLUENCE OF THE SOWING DATA CONCERNING MAIZE LEAF WEEVIL (*TANYMECUS DILATICOLLIS* GYLL) ATTACK IN ATYPICALLY CLIMATIC CONDITIONS FROM SPRING PERIOD, IN SOUTH-EAST OF ROMANIA

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Abstract

Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is main pest of the maize crop in south and south-east of the Romania. Every year, more then one million of hectares sowed with maize are attacked by this pest. Climatic conditions registered in April and May, between 2016 and 2018, at NARDI Fundulea, was atypically for this pest attack. In years 2017 and 2018, rainfalls amount was over multiyear averages, both in April and May, while average air temperature was lower then multiyear average, in May (years 2016 and 2017) and April, year 2017. Registered rainfalls amount in April and May, in year 2018 were lower while average air temperatures were higher then multiyear average. At NARDI Fundulea, it has studied maize sowing data influence, in period 2016-2018, concerning maize leaf weevil attack at maize plants in first vegetation stages (BBCH 10-BBCH 14). In the climatic conditions of the year 2016, the attack of the *T. dilaticollis* weevils was higher at untreated maize plants sowed on 27 April (I=6,01) comparative with untreated maize plants sowed on 19 May (I=5,85), but statistical differences weren't significant ($p < 0.05$). In the climatic conditions of the year 2017, the attack of the *T. dilaticollis* weevils was higher at untreated maize plants sowed on 19 May (I=5,68) comparative with untreated maize plants sowed on 27 April (I=5,30), but statistical differences weren't significant ($p < 0.05$). In the climatic conditions of the year 2018, the attack of the *T. dilaticollis* weevils was higher at untreated maize plants sowed on 25 April (I=4,61) comparative with untreated maize plants sowed on 17 May (I=4,16), in this case statistical difference was significant ($p < 0.05$). In case of variants with treated seeds with imidacloprid active ingredient, it hasn't registered significant statistical differences concerning attack intensity between plots sowed in April and plots sowed in May. In all studied years, differences between untreated variants and variants with seed treated with imidacloprid active ingredient, was significant from statistically point of view ($p < 0.05$), regardless sowing data.

Key words: maize, sowing data, weevil, attack

According MADR data (2019) in the last years, maize are cultivated on approximate 2.5 million hectares in Romania, being the one of the most important crop for this country. Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is main pest of the maize crops in south and south east of Romania (Paulian F. *et al*, 1969; Barbulescu A. *et al*, 1997; Barbulescu A., 2001; Cristea M. *et al*, 2004; Popov C. *et al*, 2007a). Each year, there were attacked approximate one million hectares cultivated with maize (Popov C. and Barbulescu A., 2007). According Paulian F. (1972) the attack is very dangerous when maize plants are in first vegetation stages, from plants emergence (BBCH 10) until four leaf stage (BBCH 14). Same author mentioned that after four leaf stage (BBCH 14), the weevils feeding only with leaf margins and the attack are not economically important. In case of high pest pressure and lack of the treatments, maize seedlings can be destroyed and farmers must sow again (Popov C. *et al*, 2007b).

Favorable area of *T. dilaticollis* is located in south and south-east of the Romania (Paulian F., 1972; Cristea M. *et al*, 2004; Popov C. *et al*, 2002). In these areas it has registered highest damages at maize crop, produced by this pest. Popov C. *et al*, (2006) mentioned that maize leaf weevil is a thermo and xerophilous insect, spread especially in arid and semi-arid areas, from south and south-east of the Romania. Same author mentioned that the weevils are very active at high air temperatures and low humidity while the low air temperatures and high rainfall amount interfere very much with their activity. Recent studies make in evidence important attack of the *T. dilaticollis* at the maize plants, in areas considered until now, unfavorable for weevils activity, such as Transylvania (Antonie I. *et al*, 2012). Possible explication for maize leaf weevil occurrence in northern areas from Romania is because of the climatic changes. Many pests can be favored by climatic changes such as increasing of the air temperature in northern latitudes

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(Cuculeanu V. *et al*, 1999; Čamprag D., 2011; Daniel P. B. *et al*, 2013). Long term studies on precipitation evolution show a decreasing trend, especially in spring period (Bozo L., 2011). Same author mentioned that, sometime, increasing precipitations is visible as a shorter term tendency.

In last 50 years, in Romania it has made many researches concerning control methods of the maize leaf weevil (Popov C. and Barbulescu A., 2007). It has researched both, cultural practices and chemical control methods. Paulian F. (1972) studied both, crop rotation and sowing data influence concerning attack of the *T. dilaticollis* at maize plants. According this author, highest attack of maize leaf weevil occurred in case of maize sowed in last 20 days of the April while lower attack occurred in case of maize sowed after the middle of the May. Recent studies make by Voinescu I. and Barbulescu A. (1998) arrives at same conclusions. Also, these authors concluded that traditional practice of cropping maize after maize, for several consecutive years greatly contributes to the reproduction of this insect and thus, to an increase in its population. In last 25 years, in Romania the number of the main crops decreasing. As result it has increasing the area with crops sowed in monoculture, including maize (Lup A. *et al*, 2013). Because of increasing of the maize area and climate change, in many cases, especially in the south and south east of Romania, farmers practice early sowing of the maize crops (Ion V. *et al*, 2013; Pravalie R. *et al*, 2017). Main conclusion on researches concerning both, crop rotation and maize sowing data is that cultural methods are not effective in control of maize leaf weevil populations (Popov C. and Barbulescu A., 2007). Until now, chemical seed treatment with systemic insecticides was the most effective method to protect maize plants, in first vegetation stages, against *T. dilaticollis* weevils attack (Kakso A., 1974; Voinescu I., 1985; Barbulescu A. *et al*, 2001; Vasilescu S. *et al*, 2005; Krusteva H. *et al*, 2006; Popov C. *et al*, 2007 a,b; Keszthelyi S. *et al*, 2008; Trotus E. *et al*, 2011; Georgescu E. *et al*, 2014). As result of European Commission Regulations 218/783, 218/784 and 218/785, the use of imidacloprid, clothianidin and thiamethoxam active ingredients for all field crops, both like seed treatment and foliar application will be total banned in UE, from 2019. After these relegations in Romania, won't remain available any active ingredients for controlling of this pest. Lack of seed treatment alternatives of the spring crops can have negative impact in Romanian agriculture in next years (Ionel I.I., 2014). In last years several studies were made for finding alternatives at seed treatment (Georgescu E. *et al*, 2014, 2016). Main

conclusions of these researches is that the alternatives at maize seed treatment with systemic insecticides are not available for control of this pest when maize plants are in first vegetation stages. Georgescu E. *et al* (2015) mentioned that atypically climatic conditions from April and May, registered in last years in Romania, favored weevils activity and, in same time, can stress maize emergence or maize plants development. The aim of this present study is to determine if the sowing data can have influence of *T. dilaticollis* weevils at maize plants in first vegetation stages (BBCH 10-BBCH 14), in atypically climatic conditions from spring period.

MATERIAL AND METHOD

The experience were carried out at Plants and Environment Protection Collective from National Agricultural Research and Development Institute (NARDI) Fundulea, Calarasi County (latitude: 44,46; longitude: 26,32; alt.: 68 m), Romania, between 2016 and 2018.

In this study it has tested two sowing periods, one at the end of April and second period after middle of May. In 2016 and 2017, maize plots were sowed in 27 April and 19 May while in 2018 maize plots were sowed in 25 April and 17 May. At each data it was sowed two variants: untreated and seeds treated with imidacloprid active ingredient. In this way it was compared both, untreated and treated variants in case of different sowing data.

Each variant has four replications. Experimental plots were arranged according randomized blocks scheme. Plot length has 10 m and plot with has 4.2 m, as result plot area has 42 m². For this study it has used maize Olt hybrid (FAO 420).

Weevils (*T. dilaticollis*) **attack intensity** was evaluated when the maize plants arrive in four leaf stage (BBCH 14), according a scale from 1 to 9, elaborated and improved by Paulian F. (1972), as follows: **note 1**-plant not attacked; **note 2**-plant with 2-3 simple bites on the leaf edge; **note 3**-plants with bites or clips on all four leaves edge; **note 4**-plants with leaves chafed in proportion of 25 %; **note 5**-plants with leaves chafed in proportion of 50 %; **note 6**-plants with leaves chafed in proportion of 75 %; **note 7**-plants with leaves chafed almost at the level of the stem; **note 8**-plants with leaves completely chafed and beginning of the stem destroyed; **note 9**-plants destroyed, with stem chafed close to soil level. At each plot it has evaluated 20 maize plants, from four central rows (5 plant/row). Before assessment, plants were marked with sticks, in „stair” system (figure 1).

After 30 days from the plant emergence it has evaluated **saved plant percent** by counting all the plants from a plot and comparing them with the sowing seeds number/plot.

Plants height was assessed at same plants that, previously it has made observations concerning attack intensity, at 50 days from maize emergence.

Meteorological data was provided by automate Pessl meteorological stations at NARDI Fundulea placed at 100 m from experimental field.

Between 2016 and 2018 it has monitoring air temperature and rainfalls occurred in spring period.

Data from the field assessments was **statistically analyzed** using **Student-Newman-Keuls test** (Student, 1927; Neuman D., 1939; Keuls M., 1952).

Table 1

Temperatures registered at NARDI Fundulea, during April-May 2016-2018

Year	Temperature (°C)				Deviation from average temperature registered in April (°C)	Deviation from average temperature registered in May (°C)
	April		May			
	Curent year	Multiyear average	Curent year	Multiyear average		
2016	14.0	11.1	16.1	16.9	+2.9	-0.8
2017	10.6		16.8		-0.5	-0.1
2018	15.8		19.4		+4.7	+2.5

Table 2

Rainfalls registered at NARDI Fundulea, during April-May 2016-2018

Year	Rainfalls (mm)				Deviation from average temperature registered in April (mm)	Deviation from average temperature registered in May (mm)
	April		May			
	Curent year	Multiyear average	Curent year	Multiyear average		
2016	73.7	59.0	81.2	72.3	+14,7	+8.9
2017	73.4		81.8		+14,4	+9.5
2018	3.8		50.6		-55.2	-21.7

Table 3

Attack intensity of *T. dilaticollis* at maize plants, in field conditions, at NARDI Fundulea

Nr. crt.	Variant	Sowing month	Attack intensity (1-9)					
			2016		2017		2018	
1	control (untreated)	April	6.01	a	5.30	a	4.61	a
2	imidacloprid (seed treatment)	May	3.73	b	3.61	b	3.45	c
3	control (untreated)	April	5.85	a	5.68	a	4.16	b
4	imidacloprid (seed treatment)	May	3.70	b	3.63	b	3.61	c
LSD P=0.05			0.404		0.554		0.376	
Standard deviation (SD)			0.253		0.346		0.235	
Variation coefficient (C.V.)			5.240		7.600		5.940	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Table 4

Influence of the sowing data concerning attack of *T. dilaticollis*, in field contitions, at NARDI Fundulea

Nr. crt.	Variant	Sowing month	Saved plant percent (%)					
			2016		2017		2018	
1	control (untreated)	April	66.34	b	82.23	b	89.94	a
2	imidacloprid (seed treatment)	May	80.99	a	87.28	a	90.66	a
3	control (untreated)	April	68.06	b	80.28	b	92.39	a
4	imidacloprid (seed treatment)	May	80.28	a	86.25	a	92.86	a
LSD P=0.05			12.496		3.492		2.900	
Standard deviation (SD)			7.813		2.183		1.813	
Variation coefficient (C.V.)			10.570		2.600		1.980	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

RESULTS AND DISCUSSIONS

Data from *tables 1 and 2* show that climatic conditions registered in last two months from spring, at NARDI Fundulea, were atypically. In 2016, average air temperature from April was higher then multiyear average and lower then multiyear average from May. In 2017, average air temperature was bellow multiyear average, both in April and May, while in 2018, average air temperature registered in April and May was higher then multiyear averages, with high positive deviation (+4.7 °C in April and +2.7 °C in May). In same time, rainfalls amount registered at NARDI Fundulea was higher then multiyear average, both in April and May, in 2016 and 2017. However, in 2018, climatic conditions from this period were different. In April it has registered only 3.8 mm of rains comparative with multiyear average (59.0 mm) while in May, total rainfalls amount was below multiyear average. From climatic point of view, in this study, in 2018 it has registered the most favorable conditions for maize leaf weevil attack (high temperatures and drought).



Figure 1 Plants marked in „stair” system

Data from *table 3* demonstrate that, in 2016 and 2017, there weren't statistical differences between attack intensity of maize leaf weevil (*T. dilaticollis*) at maize untreated plants, sowed in 27 April and 19 May ($p < 0.05$). Similar situation it has registered in case of variants with seeds treated with imidacloprid active ingredient. These results registered in first two years from this study were different with those reported by Paulian F. (1972). According this author, weevils attack was lower at plants sowed after middle of the May. The data from 2018 were in contradictions with data from literature (Popov C. *et al*, 2006). Possible explications for lower weevils attack, at untreated plants, even if the climatic conditions for these insects were very favorable, are because of daily distributions of the rainfalls amount from this period. The most of the rainfalls occurred in April

and May, was registered from 13 to 19 May, when maize plants, sowed in April were in first vegetation stages (BBCH 10-14). As result, in this short period, weather conditions weren't favorable for maize leaf weevils and the attack of this insects at maize plants, in experimental field of the NARDI Fundulea were lower comparative with 2016 and 2017, even if the overall climatic conditions from April and May (2018) were very favorable for *T. dilaticollis* weevils. In 2018, there were significant statistical differences between weevils attack registered at maize untreated plants sowed in 25 April and attack registered at maize untreated plants sowed in 17 May ($p < 0.05$).

In all studied years, on a scale from 1 to 9, the attack of weevils at maize plants from variants treated with imidacloprid active ingredient, ranged from 3.45 to 3.73 (*table 3*). Attack was low and plants recover after the attack. In all years taken in this study, at experimental field from NARDI Fundulea, there weren't statistical differences between attack at treated variants sowed in last days of April or after middle of the May ($p < 0.05$). In same time, there were significant statistical differences between attack registered at treated plots and attack registered at untreated plots. The results concerning seed treatment with imidacloprid active ingredient from this study were in accordance with those obtained by Vasilescu S. *et al* (2005), Keszthelyi S. *et al* (2008), Trotus E. *et al* (2011), Georgescu E. *et al* (2014, 2016).

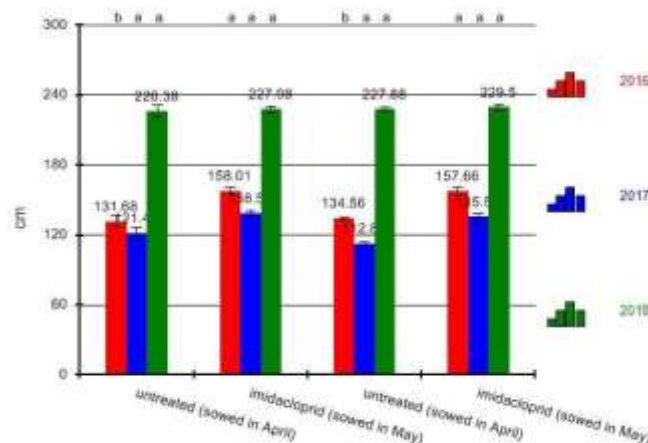


Figure 2 Plants height at 50 days from emergence

In the climatic conditions of the year 2016, saved plants percent was below 70 % at untreated plots, both sowed on 27 April and 19 May (*table 4*). At treated variants, saved plants percent was slightly higher then 80 %. In the climatic conditions of the year 2017, saved plants percent presented higher values comparative with 2016, both at treated and untreated plots, while in 2018 the differences between treated and untreated variants,

sowed both, in April and May were lower. According Student-Newman-Keuls test, there weren't statistical differences between saved plants percent registered at plots sowed at the end of the April and after middle of the May, both in 2016 and 2017 ($p < 0.05$). Similar situation was registered in case of treated plots. Sowing data didn't influence this parameter. However, in first two years from this study, it has registered higher statistical differences between untreated plots and treated plots, concerning saved plants percent ($p < 0.05$). In the climatic conditions of the year 2018, at experimental field from NARDI Fundulea, there weren't registered significant statistical differences concerning saved plants percent, both at treated and untreated variants, sowed at the end of April or after the middle of May (table 4).

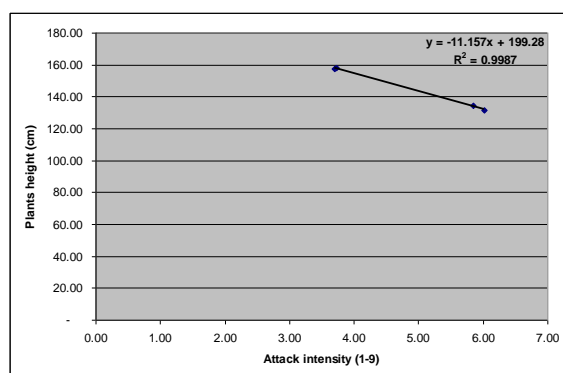


Figure 3. Relation between attack intensity of *T. dilaticollis* and maize plants height at 50 days from emergence, in 2016, at NARDI Fundulea

Concerning plant height, assessed at 50 days from the plants emergence, it has ascertained that in climatic conditions of the year 2018 it has registered highest value of this parameter (fig. 2). Possible explication for this situation is because of lower weevils attack registered in spring period of this year and high rainfalls amounts registered in June and first 15 days of the July. In the climatic conditions of the year 2017, at experimental field from NARDI Fundulea there weren't statistical differences between this parameter at both maize untreated and treated plots, sowed at the end of April and after the middle of the May. Only in 2016 it has registered higher statistical differences between treated and untreated plots concerning plant height, at 50 days from plants emergence. In same time there weren't registered statistical differences between plants height at untreated plots, sowed on 27 April and 19 May. Similar situation was ascertained in case of variants treated with imidacloprid active ingredient. In the climatic conditions of the year 2016 it was a negative relation between attack intensity attack of *T. dilaticollis* weevils at maize plants, in first vegetation stages and plants height at 50 days from

emergence (figure 3). Results from this study demonstrate that in case of atypically climatic conditions from spring period, sowing data has less relevance concerning maize leaf weevil attack at maize plants, in first vegetation stages, comparative with data from the Romanian literature (Paulian F., 1972). As result, changing of the sowing data of the maize plants, in south east of the Romania, couldn't be an alternative for chemical control of *T. dilaticollis* and couldn't replace seeds treatment. In case of variable climatic conditions from period when maize plants are in first vegetation stages (BBCH 10-BBCH 14) seed treatment with imidacloprid active ingredient provide satisfactory and constant protection against maize leaf weevil attack. At this conclusion arrive Popov C. *et al* (2006) and Georgescu E. *et al* (2015). However, further studies are necessary, in many locations from different regions of this country, to solve these aspects.

CONCLUSIONS

Between 2016 and 2018, climatic conditions from spring period registered in south-east of the Romania were atypically.

In 2016 and 2017 there weren't registered significant statistical differences between weevils attack at untreated plots sowed at the end of the April or after middle of the May. Similar situation was registered in case of variants treated with imidacloprid active ingredient.

Even if the climatic conditions from spring of 2018 were favorable for *T. dilaticollis*, however attack of weevils at maize untreated plants were lower comparative with previous two years.

Changing of the sowing data of the maize plants, in favorable area of this pest, in Romania, couldn't be an alternative for chemical control of *T. dilaticollis* and couldn't replace seeds treatment.

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ECOLOGICAL ASPECTS REGARDING BIODIVERSITY OF MICROFLORA AND FAUNA FROM CHERRY AND SOUR CHERRY ORCHARDS FROM UASVM BUCHAREST

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Abstract

Cherry and sour cherry are fruit trees, whose fruits appear first on the market. Both diseases and pests negatively influence the growth and development of fruits, the quality of fruit declining considerably, which brings important financial damage. Research on the knowledge of microflora and fauna of cherry and cherry culture was carried out in C.D.E. USAMV - Bucharest.

Diseases and pests frequently found on cherry and cherry are: blossom blight and cherry bite. To identify the fruit affected by blossom blight, the trees were examined, determining the frequency (F), the intensity (I) and the degree of attack (D.A.%) calculated. The yellow cherry on the Vega variety was placed on the cherry, and the cherry on the Wanda variety.

Observations made on cherry blossom blight showed that Celeste was the most affected, with a 33% attack frequency, an intensity of 17.3% and an attack rate of 5.7%. The Sam, Vega and Giant red varieties exhibited a very high resistance to the blossom blight attack. The most attacking species was Nana with a frequency of 37.5%.

As a result of catches made on *Rhagoletis cerasi*, the first catches were recorded on 26.04 (5 specimens/trap), with a maximum flight of 11 specimens/trap on 16.05, after which the number of catches began to fall up to 5 specimens/trap (13.06). In crush the maximum catch was recorded on 29.05, 13 insects/trap.

Key words: diseases, pests, cherry, cherry tree.

Cherries are the first fresh fruits of the year, and with their high content of vitamins, minerals, sugars, are the object of one of the most effective commercial activities. Fruits are intended for both fresh consumption and industrial processing as juices, syrups, compotes, jams etc.

Both diseases and pests negatively influence the growth and development of the fruits studied, the productivity of the orchard, the quality of the fruit decreasing considerably, which brings important financial losses.

Research on the knowledge of microflora and fauna of cherry and sour cherry culture was carried out in the Experimental Didactic Field of UASVM – Bucharest, between April and June 2018.

Diseases and pests that frequently attack cherry and sour cherry in our country are: *Monilia laxa* (blossom blight), *Myzus cerasi* (the black cherry aphid) and *Rhagoletis cerasi* (cherry fruit fly). Obtaining high yields and good quality fruit is correlated with good tree health.

In our country, by neglecting the diseases and pests of cherry and sour cherry tree, about 45-100% of the harvest of mid and late ripening

varieties can be lost (Rosca I., 2008; Istrate R., 2005, 2006, 2009). Numerous studies have been conducted by researchers on the importance of the use of resistant varieties and phytosanitary protection to reduce the incidence of the attack. (Roșca I., 2006; Manole M.S., 2007; Popa T., 2013)

MATERIAL AND METHOD

The determinations were made in the cherry and sour cherry orchards of USAMV Bucharest, where several varieties belonging to *Prunus avium* (Cherry) and *Prunus cerasus* (Sour cherry) were studied.

For the cherry tree the following varieties have been studied: Celeste, Summit, Vega, Skeena, Early red, New star, Kordia, Regina, Giorgia, Ferrovia, Mora di Vignola, Firm red, Giant red, Katalin, Ulster, Sam, Burlat, Hedelfinger, Cetățuia, Bigareau Burlat, Margo, Lucia.

For the sour cherry tree the varieties studied were: Northstar, Schattenmorelle, Nana, Montmorency, De Botoșani.

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The trees were planted at a distance of 4 meters between the rows and 1 meter between trees in a row, without stakes, and the shape of the crown is a vertical axis and a bush.

At the approach of fruit ripening (the third decade of May), in order to determine the phytosanitary status, all trees were examined as they are placed randomly on the rows.

Observations and harvesting of biological fauna material have been carried out during the vegetation period, from May to June.

Samples were harvested weekly, using adhesive yellow traps (Pherocon AM), installed at heights of 1.5 m and 2.5 m (figure 1a, b).

The adhesive yellow traps were installed on the Vega variety for the cherry tree, and on the Wanda variety for the sour cherry tree, to collect the species *Rhagoletis cerasi*.

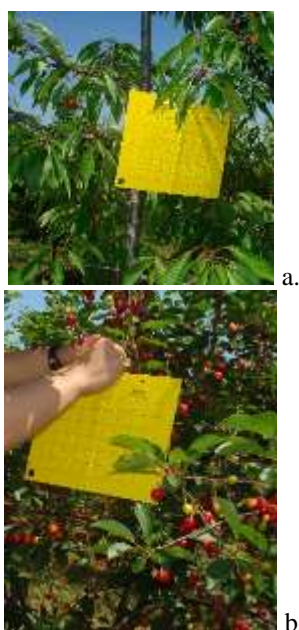


Figure 1 (a, b) Installation of adhesive yellow traps in cherries and sour cherries

RESULTS AND DISCUSSIONS

Following the observations made on varieties from the U.S.A.M.V. Bucharest orchard, at both species were identified with the *Monilinia laxa* (Aderh. & Ruhland) Honey (Fungi, Ascomycota, Leotiomyces) pathogen responsible for the occurrence of fruit blossom blight. The studied varieties may have different sensitivities to pathogen attack depending on the thickness of the cuticle. The cuticle of fruit is, generally, known to have a protective role and, in cherry fruit and cherry tree, the cuticle has been reported to take part in resistance against *Monilinia* (Brown, S., 1989).

Observations aimed to determine the incidence of frequency and intensity, based on which the degree of attack on cherries and cherries was calculated.

Aspects of blossom blight attack are presented in figure 2. The incidence of frequency (F%) and intensity (I%) were determined, on which the degree of attack (D.A.) of fruit blossom blight was calculated.



Figure 2 (a, b) Symptom of *Monilinia laxa* on the fruit

In cherry trees, out of the varieties analyzed, the frequency of the attack (F%) showed values of: 20% for Kordia, Bigareau Burlat 25% and Celeste 33%. The highest intensity of blossom blight was found in the Kordia variety of 18.3%, followed by Celeste with 17.3%, Bigareau Burlat of 15% and Hedelfinger of 11.7%. The Sam, Vega and Giant red varieties showed a high resistance to the blossom blight attack, and the pathogen not being detected under the randomization of the varieties. The degree of attack rate (D.A.%) had low values between 1.17% for Hedelfinger and 5.7% for Celeste (figure 3).

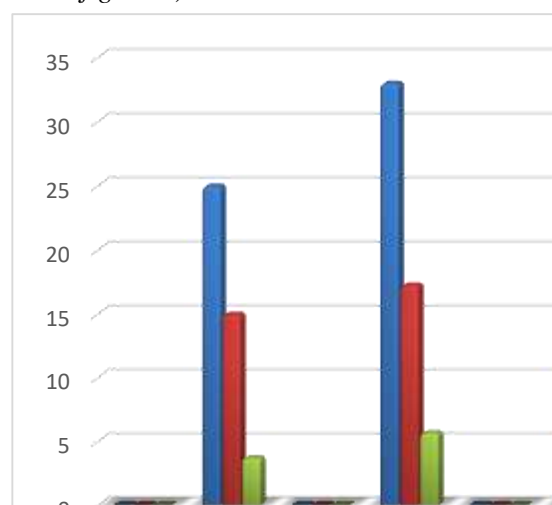


Figure 3 Evolution of the incidence of blossom blight (*Monilinia laxa*) on cherries

Due to the phytosanitary treatments applied periodically against diseases and pests, many of the trees did not show symptoms of attack, some of them being resistant to fruit *Monilinia laxa*.

The results show that some varieties such as Sam, Vega and Giant red are resistant to pathogenic agent attack.

For sour cherry tree the following varieties were analyzed: Northstar, Schattenmorelle, Nana, Montmorency, De Botosani (figure 4).

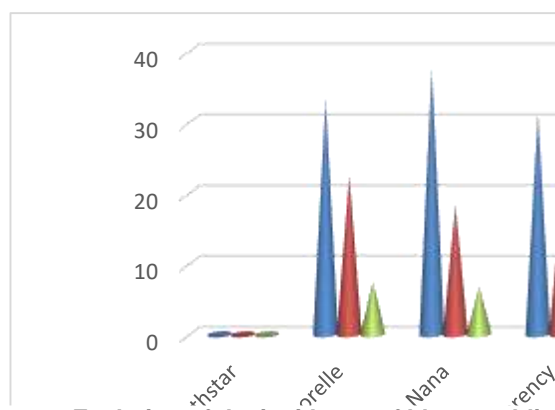


Figure 4 Evolution of the incidence of blossom blight (*Monilinia laxa*) on sour cherries

The *Monilinia laxa* attack presented values in frequency between 20% in the De Botosani variety and 37.5% in the Nana variety, except for the Northstar variety, without attack. The highest attack intensity was recorded in the Schattenmorelle variety of 22.5%, where a maximum attack rate of 7.49% was calculated.

The lowest value of the attack was 4% in the Botosani variety.

The attack of *Rhagoletis cerasi* species, based on catches made on the adhesive yellow traps, was separately evidenced on cherries and sour cherries (figure 5).



Figure 5 Catching the species *Rhagoletis cerasi*

In the cherry tree, based on weekly catches, the dynamics of the species was established, i.e. at the beginning and end of the adult occurrence in the tree crown (figure 6).

The first catches of 5 adults/trap were recorded towards the end of May, early June (26.04 and 03.05).

In June, the number of catches declined to only 5 adults/trap in the second decade of the month (13.06-20.06).

During the observation period, a number of 51 catches were recorded.

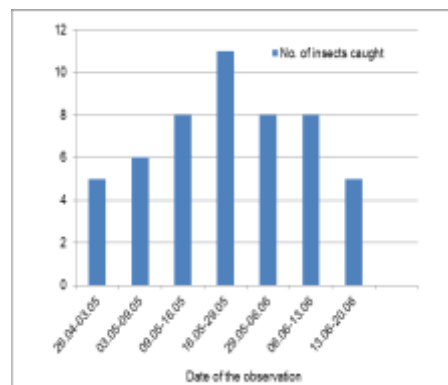


Figure 6 Dynamics of *Rhagoletis cerasi* species in cherry

The species population began to grow at a maximum flight of 11 adults/trap in week 16.05-29.05, period coinciding with the fruit ripening phenophase (table 1).

Table 1
Evolution of the species *Rhagoletis cerasi* in cherry

Date of the observation	No. of insects caught
26.04-03.05	5
03.05-09.05	6
09.05-16.05	8
16.05-29.05	11
29.05-06.06	8
06.06-13.06	8
13.06-20.06	5
Total insects	51

In sour cherry, the cherry fly appeared at the end of April with 2 adults/trap, after which the population started to increase, with a maximum flight at the end of May, early June (29.05 - 06.06) of 13 adults/trap (table 2).

Table 2
Evolution of *Rhagoletis cerasi* species in sour cherry

Date of the observation	No. of insects caught
26.04-03.05	2
03.05-09.05	6
09.05-16.05	7
16.05-29.05	6
29.05-06.06	13
06.06-20.06	8
Total	42

The population is less numerous in sour cherry trees, of only 42 adults, during the observation months (April, May and June).

The dynamics of the species show that the cherry fly appears in the tree crown towards the end of April, after which the population starts to grow progressively, with a maximum of 13 adults/trap in late May - early June (29.05 – 06.06), then decreases to 8 adults/trap in the first and second decades of June (figure 7).

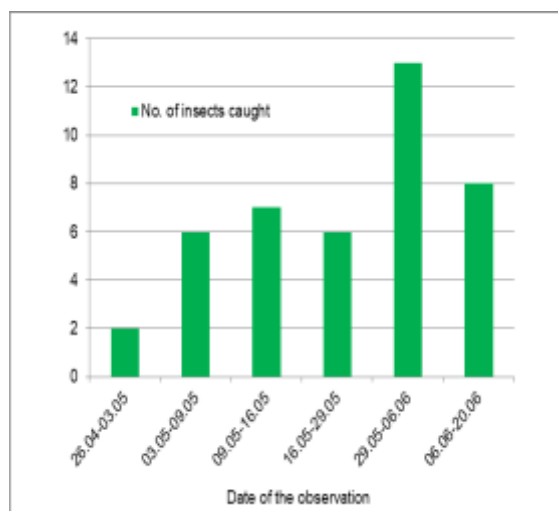


Figure 7 The dynamics of the *Rhagoletis cerasi* species in sour cherry

CONCLUSIONS

Of the cherry tree varieties analyzed, the Sam, Vega and Giant red varieties proved to be immune to attack pathogen *Monilinia laxa*, according to the description of the variety. The most affected species was Celeste, while the Kordia variety proved to be the least affected.

Regarding the sour cherry, among the studied varieties, the most affected was Nana, and the least affected was Vișinul de Botoșani.

Adhesive yellow traps show great attraction, proving useful in establishing the population level of *Rhagoletis cerasi* L., and its dynamics, leading to the application of warning treatments at optimum times.

Based on the observations made, it can be noticed that in 2018 the population of *Rhagoletis cerasi* L., showed a high density in May and June, depreciating the quality of fruits of early and mid-ripening varieties. The most intense action of the adult *Rhagoletis cerasi* on the cherry tree was carried out between May 16 and May 29, when 11 adults were harvested from the traps in the orchard.

Analyzing the sour cherry, it was found that the adult species *Rhagoletis cerasi* was more

present between May 29 and June 6, when 13 individuals were harvested from the traps.

Both the action of the diseases and the action of the pests are strongly influenced by the phytosanitary treatments that are applied periodically in the orchard in order to protect the trees and to maximize the harvest.

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BIODIVERSITY OF MICROFLORA AND HARMFUL FAUNA IN APPLE ORCHARDS FROM UASVM BUCHAREST

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Abstract

In Romania the knowledge of the main diseases and pests that occur during the apple vegetation period is a priority in the cultivation technology of this fruit tree species. The proposed studies aim at collecting information on the control of diseases and the microlepidopter population in order to establish the phytosanitary status of apple plantation. The research was carried out in the USAMV - Bucharest didactic field, in the apple orchard, and all apple varieties were studied, where the degree of attack was calculated based on the frequency and intensity of the diseases. The distinctive Golden Orange variety was the most attacked, with the *Podosphaera leucotricha* shoots at 70% and the intensity of 85%. This variety has the same high sensitivity to *Venturia inaequalis*, namely 80% frequency and 65% intensity. Microlepidopter surveillance in the apple orchard was performed using the pheromone trap (AtraPom). Pheromone traps were placed in the tree crown from late April to June. They were placed on three diagonals and 1.5 m high. Weekly observations highlighted that the first catches were recorded at the beginning of May (3 adults / trap), with a maximum flight in the in the second decade of May (7 adults/trap) and the last catches were in the second decade of May (2 adults/trap), with a single flight corresponding to the first generation.

Key words: diseases, microlepidopters, pheromones

In Romania, the tree crops occupy an area of 138000 ha, concentrated mainly in hilly areas, where climatic conditions are more favorable than in the open, due to more frequent precipitation and the more balanced thermal regime (madr.ro).

Of the total area, the apple occupies 55500 ha, ranking first, with a production of over 467.2 million tonnes. Lately, small family apple plantations have been expanding, which will mostly ensure the farmers' own consumption. It is necessary that in Romania also, the apple production to grow based on a considerable increase in yields of orchards and not on their surfaces. Apples are the fruit with the greatest weight in human consumption. This impact is due to the wide range of distribution, the variety of assortment and storage throughout the year.

Therefore, knowing the main diseases and pests that occur during the vegetation period of the apple, is a priority in the cultivation technology of this fruit tree species.

The proposed studies aim at collecting information on disease control and microlepidopter population in order to determine the phytosanitary status of the apple plantation to apply the correct treatments to combat pest.

The importance of the using resistant

varieties and chemicals that reduce the incidence of diseases (Manole, 2007; Popa *et al*, 2013) and the use of pheromones has been demonstrated in numerous papers by researchers from various institutes in the country: (Iacob, 1977; Iacob and Iacob, 1979; Susea, 1985; Ghizdavu, 1983; Drosu, 1993; Istrate, 2004; Rosca and Istrate, 2006; Istrate and Rosca, 2007, 2009; Teodorescu, 2001). However, we believe that we must maintain current the importance of the use of sex pheromones in integrated pest control programs, especially in pomiculture (Rosca *et al*, 2006).

MATERIAL AND METHOD

The research was carried out in the USAMV - Bucharest didactic field, in the apple orchard, and all the apple varieties in the orchard were studied. All trees were analyzed (*table 1*) as they are randomly placed on the row, at a planting distance of 3.5 x 1 m.

The quantitative assessment of the attack was carried out at two moments (May 3/ June 14) by examining the trees, determining the incidence of frequency (F%) and intensity (I%), based on which the degree of attack was calculated (D.A.%).

The surveillance of the microlepidopters in the apple orchard was performed using the

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AtraPom pheromone trap with adhesive (figure 1). The pheromone traps were placed in the tree crown, at the edges and in the center of experimental variations from the end of April to June. They were placed on three rows diagonally, and at a height of 1.5 m.

Through weekly tracing of the pheromone traps, the dynamics of the species *Cydia pomonella* (the apple worm) was compiled.

The research took place from April to June, in an apple plantation with a height of 2-3.5 m, with all apple varieties in the USAMV-Bucharest orchard, and the predominant varieties were: Redix and Generos.

Table 1

The varieties on which the quantitative assessment was carried out

Crt. No.	Variety	No.trees
1	Golden Orange	7
2	Golden Reinders	5
3	Jonagored Morena	5
4	Red Chief	1
5	Pinova	9
6	Jonagold 'Red Prince'	4
7	Polka	4
8	Braeburn	5
9	Gala King	10
10	Red Elstar	10
11	Jonafree	9
12	Remo	7
13	Fuji 'kiku8'	5
14	Rene	3
15	Florina	5
16	Aura	5
17	Romus 3	5
18	Stark Prim	5
19	Jonaprim	5
20	Bistrítean	5
21	Ciprian	5
22	Red Topaz	5
23	Iris	5
24	Rebra	5
25	Pionier	5
26	Generos	53
27	Redix	53



a.



b.

Figure 1 Installing pheromone traps

RESULTS AND DISCUSSIONS

Following the observations made on the varieties of apple in the USAMV-Bucharest orchard, the following pathogens were identified: *Podosphaera leucotricha*, which produces apple mildew (figure 2), *Venturia inaequalis* (figure 3), responsible for producing leaf patches and branches and fruits scabbing, and *Monilinia fructigena*, producing moniliosis (figure 4).

Figure 2 *Podosphaera leucotricha* – attacked spring

The incidence of frequency (%) and intensity (%) are shown in table 2. For mildewing were determined values of frequency on the first observation that do not exceed 55% for the Fuji 'kiku8' variety, and on the second observation, the maximum value of frequency was 70% at Golden Orange, which initially presented a percentage of 30%.



Figure 3 **Brown staining and apple scab - *Venturia inaequalis***



Figure 4 **Fruit mummification – *Monilinia fructigena***

Based on this data it was calculated the degree of attack on the apple varieties that presented attacks. (table 3).

Table 2

Incidence of pathogens in the varieties studied

Crt. No.	Variety	Frequency F %						Intensity I %					
		<i>Podosphaera leucotricha</i>		<i>Venturia inaequalis</i>		<i>Monilinia fructigena</i>		<i>Podosphaera leucotricha</i>		<i>Venturia inaequalis</i>		<i>Monilinia fructigena</i>	
	Moment of observations	1*	2*	1*	2*	1*	2*	1*	2*	1*	2*	1*	2*
1	Golden Orange	30	70	20	80	10	20	50	85	15	65	15	25
2	Golden Reinders	15	20	20	75	10	15	25	30	20	55	5	10
3	Jonagored Morena	30	35	10	30	5	5	30	40	15	45	15	20
4	Red Chief	0	0	15	25	5	10	0	0	15	25	10	20
5	Pinova	5	10	0	0	0	0	5	15	0	0	0	0
6	Jonagold'RedPrince'	40	50	20	45	5	5	50	65	10	30	10	15
7	Polka	25	30	0	0	0	0	30	45	0	0	0	0
8	Braeburn	40	55	20	65	20	25	30	40	25	55	25	30
9	Gala King	30	40	20	45	15	20	35	45	25	50	10	15
10	Red Elstar	15	20	5	10	5	5	20	25	5	15	5	10
11	Jonafree	30	40	0	5	0	0	25	35	0	5	0	0
12	Remo	0	0	0	0	0	0	0	0	0	0	0	0
13	Fuji 'kiku8'	55	65	5	10	0	0	40	50	10	15	0	0
14	Rene	5	10	10	25	0	0	10	15	5	20	0	0
15	Florina	0	0	0	0	0	0	0	0	0	0	0	0
16	Aura	0	0	0	0	0	0	0	0	0	0	0	0
17	Romus 3	0	0	0	0	0	0	0	0	0	0	0	0
18	Stark Prim	0	0	0	5	0	0	0	0	0	10	0	0
19	Jonaprim	0	0	0	0	0	0	0	0	0	0	0	0
20	Bistrițean	0	0	0	0	0	5	0	0	0	0	0	5
21	Ciprian	0	0	0	0	0	0	0	0	0	0	0	0
22	Red Topaz	0	0	0	0	0	0	0	0	0	0	0	0
23	Iris	0	0	0	0	0	10	0	0	0	0	0	5
24	Rebra	0	0	0	0	0	0	0	0	0	0	0	0
25	Pionier	0	0	0	0	0	0	0	0	0	0	0	0
26	Generos	0	0	0	0	0	0	0	0	0	0	0	0
27	Redix	0	0	0	0	0	0	0	0	0	0	0	0

1*= observations in May 3rd 2018

2*= observations in June 14th 2018

From the results we can say that the most sensitive varieties for pathogen attacks are: Golden Orange, Golden Reinders, Jonagold Morena, Jonagold 'Red Prince', Braeburn, Gala King, Red Elstar, Jonafree and Fuji 'kiku8'.

The Golden Orange variety was the most attacked, having a frequency for *Podosphaera leucotricha* on sprigs of 70% and an intensity of 85%. Also, this variety presents the same high sensitivity to the *Venturia inaequalis* pathogen,

with an 80% frequency and a 65% intensity, respectively.

Another variety that shows low resistance to mildew, scab and brown rot is Braeburn which exhibits a 55% attack rate on *Podosphaera leucotricha* and 65% on *Venturia inaequalis*. For *Monilinia fructigena*, the frequency values at first observation did not exceed 25% (Braeburn variety), 25% on the second survey respectively.

The intensity of the pathogen attack on the studied varieties varied depending on them, from 50% at the first assessment of the sanitary condition of the trees, to 85% at a second evaluation. The highest incidence was recorded in the pathogen *Podosphaera leucotricha* and the

lowest incidence was found in the pathogen *Monilinia fructigena*.

For *Podosphaera leucotricha* at the first determination, although the highest degree of attack was recorded in the Jonagold 'Red Prince' variety, 20%, on 14 June it had an attack degree below the maximum value recorded in the Golden Orange variety with 59.5 % (table 3).

Sporadic attacks were recorded in the other varieties, but with an insignificant percentage. Most of the varieties did not show symptoms of attack, due to their resistance to the pathogens studied, as well as due to the treatments to combat them.

Table 3

Evolution of pathogen attack (D.A.%)

Variety/ Pathogen	<i>Podosphaera leucotricha</i>		<i>Venturia inaequalis</i>		<i>Monilinia fructigena</i>	
	1*	2*	1*	2*	1*	2*
Golden Orange	15	59.5	3	52	1.5	5
Golden Reinders	3.75	6	4	41.2	0.5	1.5
Jonagored Morena	9	14	1.5	13.5	0.75	1
Red Chief	0	0	2.25	6.2	0.15	2
Pinova	0.25	1.5	0	0	0	0
Jonagold 'Red Prince'	20	32.5	2	13.5	0.15	0.7
Polka	7.5	13.5	0	0	0	0
Braeburn	12	22	5	35.7	5	7.5
Gala King	10.5	18	5	22.5	1.5	3
Red Elstar	3	5	0.25	1.5	0.25	0.5
Jonafree	7.5	14	0	0.25	0	0
Fuji 'kiku8'	22	32.5	0.5	1.5	0	0
Rene	0.5	1.5	0.5	5	0	0
Stark Prim	0	0	0	0.5	0	0
Bistrițean	0	0	0	0	0	0.2
Iris	0	0	0	0	0	0.5

1*= observations in May 3rd 2018

2*= observations in June 14th 2018

Observations on harmful fauna were carried out on *Cydia pomonella* (the apple worm) with the help of AtraPom pheromone traps. The catches were recorded weekly, with adults being taken out of the trap at each observation (figure 5).



Figure 5 Capture of adults of the *Cydia pomonella* species

The replacement of the pheromone capsules was done at 4 weeks. The data obtained from each trap was recorded in tables and, based on the butterflies captured at each observation, the flight curve was established, to track more easily the evolution of the pest population (figure 6).

The AtraPom pheromone proved to be specific to *Cydia pomonella* L., no other species were caught in the traps. Under the conditions specific to Bucharest area, the apple worm presents three generations per year: G1 - April to June; G2 - July to early August; G3 - August to September (Istrate, 2009; Roșca, 2001) and in this paper we caught the first generation. In 2018, April began with a temperature of 9.8°C, followed by a period of low temperatures of 6.5-6.9°C.

The population of the first generation was less numerous, the first catches were made on 03.05.2018 (3 adults/ trap) at 25°C.

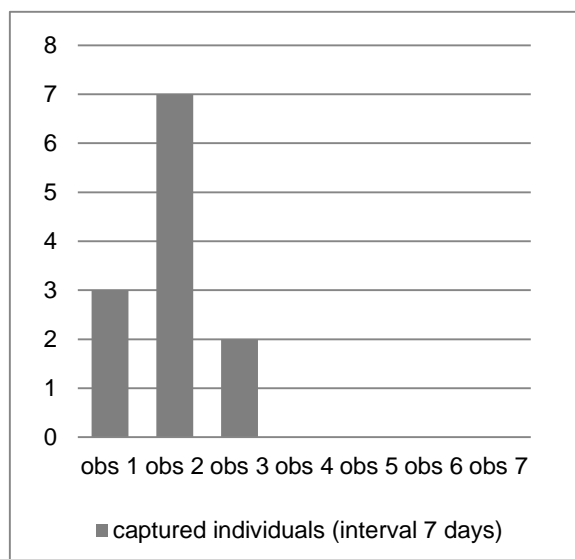


Figure 6 Dynamics of the species *Cydia pomonella*

The flight curve of the species has a progressive increase, reaching a maximum flight of 7 adults/ trap, recorded on 10.05.2018, and the last captures were recorded on 17.05.2018 (2 adults/ trap).

With the weekly tracing of pheromone traps, it was reported that the first catches were recorded in the first decade of May, and last in the second decade of May, recording a single flight, which corresponds to the first generation.

The use of pheromone traps provided us with objective and real data on the dynamics and number of the populations of *Cydia pomonella* L., successfully used to establish the prognosis and warning of treatments.

CONCLUSIONS

The pathogen *Podosphaera leucotricha* had an incidence of up to 70%, with a maximum intensity of 85%, the most attacked variety of apple being the Golden Orange.

Most attacked by *Venturia inaequalis* was the Golden Orange apple variety, with a high frequency of 80% and a maximum intensity of 65%.

Most affected by the *Monilinia fructigena* pathogen was the Braeburn apple variety with an attack rate of 7.5%.

The most resistant varieties that did not show any symptoms and were not attacked by the diseases described are: Redix, Generos, Pionier, Rebra, Red Topaz, Ciprian, Jonaprim, Romus 3, Aura, Florina and Remo.

The synthetic sex pheromone AtrPom has shown great power of attraction, proving practical and useful in knowing the population level of the

apple worm (*Cydia pomonella* L.), the dynamics of its population, and the application of chemical treatments at optimal moments.

The dynamics of the *Cydia pomonella* species during the months of May-June 2018, highlighted the evolution of the first generation.

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THE INFLUENCE OF TREATMENTS WITH DIFFERENT PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI AND ON BARLEY HARVEST – SALMANDRE VARIETY - IN 2018 PEDOCLIMATIC CONDITIONS OF THE EASTERN BARAGAN

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Abstract

Barley is attacked during the vegetation period by many pathogenic agents. One of these pathogenic agents, *Pyrenophora graminea* fungus producing the barley's leaf stripe (Velichi E. 2012) appeared in the Eastern Baragan area in 2018. An experiment took place in 2018, where 4 products of phytosanitary usage were used, as follows: ACANTO PLUS (picoxistrobin 200g/l + cyproconazole 80 g/l), MYSTIC 250 EC (tebuconazole 250 g/l) and FALCON 460 EC (triadimenole 43 g/l + tebuconazole 167 g/l + spiroxamine 250 g/l). This experiment consisted in 7 variants (6 variants with phytosanitary treatments in different combinations of products, plus one control variant not treated). The experiment was placed in Latin square. The 7 variants were placed in 7 repetitions. Among the pathogenic agents monitored, the greatest attacks were produced by *Pyrenophora graminea* fungus, which produces the tearing of barley's leaves. The first two leaves below the spike were analyzed for this. The observations showed that the degree of attack (D.A %) of the disease (barley's leaf stripe) was more reduced at all 6 variants of treatment than that of the control variant, V7. The harvests of the treated variants (V1 ... V6) were higher than the harvest of the untreated control variant, V7. The harvests of treatment variants were significantly higher than the harvest of the untreated control variant (statistical assurance, LD 5%), except for V1, where the harvest increment has no statistical assurance. In what concerns the economic efficiency, like in the study performed in the year 2016, the fungicide product MYSTIC 250 EC 0.5 l/ha has proved to be the most efficient from price point of view.

Key words: *Pyrenophora*, cyproconazole, Latin square

Hordeum vulgare barley is under attack of many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe - *Pyrenophora graminea*, leaf blotch - *Rhynchosporium secalis*, rust - *Puccinia hordei* (Jacob V. *et al*, 1998). The first half of the year 2018 was very good for barley, even if, starting from April, it had been very droughty. The winter was very rich in rainfalls and also the month of March. Among the pathogenic agents which appeared, we mention *Pyrenophora graminea* fungus which produces the disease called leaf stripe at barley. This pathogenic agent attacks the barley crops each year, at attack intensities which vary each and every year. The other pathogenic agents mentioned had occurred sporadically in the year 2018 at barley's experiment.

MATERIAL AND METHOD

For performing the observations, an experiment with 7 study variants was conceived. This experiment comprised 6 variants of

phytosanitary treatment (fungicide products, their combinations, number of treatments) and a control variant not treated. The variants of the experiment were the following (tab.1):

- V1 ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018);
- V2 ACANTO PLUS 0.5 L/HA 1 treatment applied at "bellows" phase (11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018);
- V3 FALCON 460 EC – 0.7 L/HA 1 treatment applied at spike's release - blooming (1.05.2018);
- V4 FALCON 460 EC - 0,7 L/HA 1 treatment applied at "bellows" phase (11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018);
- V5 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018);
- V6 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at "bellows" phase (11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018);
- V7 Untreated control variant.

We mention that FALCON 460 EC product is homologated for barley in a dosage of 0.6 l/ha. For

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wheat, it is homologated in a dosage of 0.6 l/ha for a complex of foliar diseases and 0.7 l/ha when there is high pressure of infection at blooming and there is a high risk of attack of the fungi from *Fusarium* sp. variety. The dosage of 0.7 l/ha was used for our experiment at barley in order to observe the efficiency of this slightly increased dosage at this variety.

The experiment was placed in randomized blocks. These 7 variants were placed in 7 repetitions. Each experimental parcel had an area of 15 m² (5 x 3m). The total number of experimental parcels was of 49. The area of an experimental variant was of 15 m² x 7 repetitions = 105 m². The total area of the experiment was of 105 m² x 7 = 735 m². The treatments were executed manually, with a machine of "vermorel" type. "Trend" adjuvant product was added in the irrigation solution, in concentration of 0.03%. Weeds control was done with the help of Rival Star 75 GD herbicide, in a dosage of 15 g/ha. The experiment had as purpose establishing the efficiency of the mentioned phytosanitary products, reported to their price, as well as the efficiency and respectively the lucrativeness of applying one or two phytosanitary treatments during the barley's vegetation period.

The evaluation of the attack's frequency (F%), of the intensity of the attack (I%) and respectively, of the degree of attack (D.A.%) was done separately, on each and every experimental parcel, analyzing 10 plants / experimental parcel. To them it was assessed the degree of affectation (the intensity of the attack I %) of the last 2 leaves, especially of the "flag" leaf, which has the biggest contribution to the production of a spike at cereals. The phytosanitary analyses of the plants samples were done with the help of the stereomicroscope and of the optic microscope at Brăila Phytosanitary Office's laboratory – Phytosanitary National Authority, institution subordinated to the Ministry of Agriculture and Rural Development. These analyses had revealed the presence of *Pyrenophora graminea* fungus in the samples analyzed, which produces the barley's leaf stripe.

In order to assess the harvest of each variant under study, there had been analysed on a percentage sample basis kernel samples from each experimental parcel, 5 samples / parcel. Each sample comprised 10 plants, so, from each experimental plot, 50 plants were taken over, from which the harvest was manually weighted. The demarcation of each sample was performed with a metric frame with the area of 0.25 m² (0.5/0.5m). The average of the experimental parcel samples had served for calculating the production of each and every experimental parcel. The statistic interpretation had been done with the help of the limit differences (LD %) (Săulescu N).

The variety used was Salamandre. This is a French variety of barley for beer, produced by Soufflet Company. The variety is forward and has a good production potential. Also, this variety is

tolerant at barley's main diseases (Soufflet. Agro Romania 2019).

Assessing the attack of a damaging agent can be done with the help of values (Prognosis and Warning Methods, 1980):

- Attack frequency (F %);
- Attack intensity (I %);
- Degree of attack (D.A %).

- Attack frequency represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of plants or organs observed (N). The value of the frequency is established through direct observations on a number of plants or organs, according to the case and to the conditions, existing different methods of collecting the samples and of performing the observations. In the case of our observations regarding the foliar diseases, there had been taken into consideration the number of organs of plants attacked from the total of organs of plants observed (leaves), establishing thus the frequency of the attack expressed in percentages %. In case of blights, it had been used the number of spikes attacked, reported to the total number of spikes observed. The frequency was calculated with the help of the formula $F\% = \frac{n \times 100}{N}$.

- Attack intensity represents the degree or percentage in which a plant or an organ of the plant is attacked and how much from the area of the plant or of the organ analysed (leaf, fruit) is covered by the disease under study.

The assessment of the area attacked had been done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. The damage percentage can be recorded or grades can be awarded for each plant or organ attacked by the disease or/and by the pest. Grades usage can ease up greatly data summarizing. It can be used a scale with 6 degrees of intensity, as follows:

- Grade 0	no attack
- Grade 1	attack 1 – 3%
- Grade 2	attack 3 – 10%
- Grade 3	attack 11 – 25%
- Grade 4	attack 26 – 50%
- Grade 5	attack 51 – 75%
- Grade 6	attack 76 – 100%

After summarizing the data, the attack intensity had been determined with the following formula:

$$I\% = \frac{\sum (i \times f)}{n}$$

Where:

I% - Attack intensity (in %);

i – The intensity according to the grade awarded to the organ or plant attacked;

f – The number of cases (plants, organs) attacked;

n – The number of plants attacked.

In the case of our experiment, grades from 1 to 6 had been awarded, separately, to “flag” leaf and to the next leaf situated below it.

- The attack degree is the expression of the extension of the gravity of the attack on the crop or on the total number of plants for which we are making the observations. The value expression of DA is given by the relation:

$$D.A. (\%) = \frac{F \times I}{100}$$

In most of the cases, there is a negative correlation between the degree of attack of a pathogenic agent or pest and the quantitative and/or qualitative level of the production of a crop.

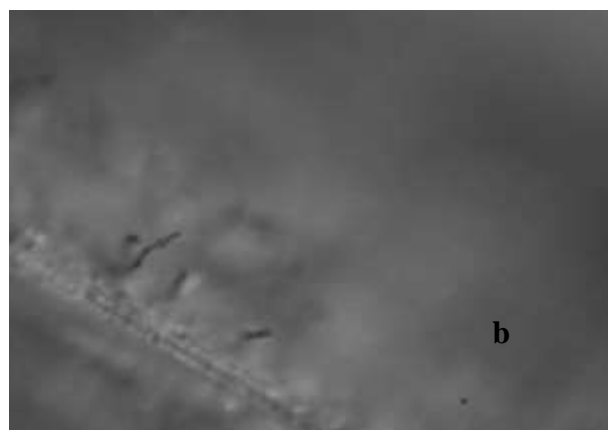


Figure 1 Barley's leaf stripe, *Pyrenophora graminea* (beginning of the attack) a – attack on leaves, b – conidia (original)

Table 1

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the attack (D.A. %) of *Pyrenophora graminea* fungus at barley (“flag” leaf and the next leaf). The observations were performed on the date of May 22nd 2018

Variant	“flag” leaf			The second leaf		
	D.A%	Difference as compared to control variant	Significance	D.A%	Difference as compared to control variant	Significance
V1 ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018)	6.4	21.8	***	33.2	55.0	***
V2 ACANTO PLUS 0.5 L/HA 1 treatment applied at “bellows” phase(11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018)	0.9	27.3	***	21.5	66.7	***
V3 FALCON 460 EC - 0.7 L/HA 1 treatment applied at spike's release - blooming (1.05.2018)	7.8	20.4	***	54.1	34.1	***
V4 FALCON 460 EC - 0.7 L/HA 1 treatment applied at “bellows” phase(11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018)	5.6	22.6	***	59.3	28.9	**
V5 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018);	14.7	13.5	*	77.9	10.3	Not significant
V6 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at “bellows” phase (11.04.2018)+1 treatment applied at the beginning of kernel's filling (10.05.2018)	11.5	16.7	**	84.3	3.9	Not significant
V7 -Untreated control variant.	28.2	-	-	88.2	-	-

LD D.A.% for “flag” leaf

LD 5% = 10.27%

LD 1% = 13.78%

LD 0.1% = 18.16%

LD D.A.% for the second leaf:

LD 5% = 17.47%

LD 1% = 23.41%

LD 0.1% = 30.90%



Figure 2 Aspects from the experiment field in the phase of occurrence of the spike (original)

Table 2

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the harvest (t/ha) obtained at the variants treated as compared to the untreated control variant

Variant	Harvest (t/ha)	Difference as compared to the control variant (t/ha)	Significance
V1 ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018)	7.688	0.323	Not significant
V2 ACANTO PLUS 0.5 L/HA 1 treatment applied at "bellows" phase (11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018)	7.789	0.424	*
V3 FALCON 460 EC - 0.7 L/HA 1 treatment applied at spike's release - blooming (1.05.2018)	7.911	0.546	**
V4 FALCON 460 EC - 0.7 L/HA 1 treatment applied at "bellows" phase (11.04.2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018)	7.769	0.404	*
V5 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018);	7.870	0.505	**
V6 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at "bellows" phase (11.04.2018)+1 treatment applied at the beginning of kernel's filling (10.05.2018)	7.728	0.363	*
V7 Untreated control variant.	7.365	-	-

LD 5% = 0.343 t/ha

LD 1% = 0.469 t/ha

LD 0.1% = 0.606 t/ha

RESULTS AND DISCUSSIONS

The agricultural year 2018 – 2019 was a slightly difficult year for barley crop from the point of view of the attacks of the pathogenic agents specific to this cultivated variety. It must be underlined the very important fact that barley (*Hordeum vulgare*) is a variety more sensible to the attack of the diseases than wheat. April and May months were hotter and very poor in rainfalls.

In these months, only 1.5 l/m² rainfalls were recorded in April and 25.4 m/m² rainfalls were recorded in May. The average temperatures registered were 15° C in April and 18.5°C in May.

In what concerns the dynamic of the occurrence of the pathogenic attacks at barley, we mention the following aspects:

- *Pyrenophora graminea* had affected the barley in a smaller extent than in the previous years. However, it was necessary to apply phytosanitary treatments. The degree of attack

(D.A. %) was of 28.2% at variant V7 - untreated control sample, on the date of 22nd May 2018, at “flag” leaf. It must be underlined the fact that this pathogen had proven to be the most dangerous pathogenic agent of barley, like in the previous years.

- *Rhynchosporium secalis* (leaf scald) and *Blumeria (Erysiphe) graminis* f. sp. *Hordei* (mildew) had not significantly affected the barley in the spring of the year 2018 (D.A. < 0.5%).
- Barley's rust (*Puccinia hordei*) has not affected significantly the barley (D.A. < 1.0%).

If we analyse the data from Table 1, we observe that the degree of attack of the fungus *Pyrenophora graminea* was differentiated as follows:

- V1 ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release (01.05.2018) had determined a degree of attack of *Pyrenophora graminis* fungus of 6.4% at the flag leaf and of 33.2% at the second leaf, so lower by 21.8% and respectively, by 55.0% as compared to the untreated control variant (V7).
- V2 ACANTO PLUS 0.5 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018) had determined a degree of attack of *Pyrenophora graminea* fungus of 0.9% at the flag leaf and of 21.5% at the second leaf, so lower by 66.7%, and respectively by 27.3% as compared to the untreated control variant (V7).
- V3 FALCON 460 EC – 0.7 L/HA 1 treatment applied at spike's release - blooming (1.05. 2018) had determined a degree of attack of *Pyrenophora graminea* fungus of 7.8% at the flag leaf and of 54.1% at the second leaf, so lower by 20.4% and respectively by 34.1% as compared to the untreated control variant (V7).
- V4 FALCON 460 EC – 0.7 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05. 2018) had determined a degree of attack of *Pyrenophora graminis* fungus of 5.6% at the flag leaf and of 59.3% at the second leaf, so lower by 22.6% and respectively by 28.9% as compared to the untreated control variant (V7).
- V5 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05.2018) had determined a degree of attack of *Pyrenophora graminis* fungus of 14.7% at flag leaf and of 77.9% at the second leaf, so lower by 13.5% and respectively by 10.3% as

compared to the untreated control variant (V7).

- V6 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018) had determined a degree of attack of *Pyrenophora graminis* fungus of 11.5% at flag leaf and of 84.3% at the second leaf, so lower by 16.7% and respectively by 3.9% as compared to the untreated control variant (V7).
- V7 Untreated control variant was affected by *Pyrenophora graminis* at values of the degree of attack (D.A.%) of 28.2% at the flag leaf and of 88.2% at the second leaf.

Out of the analysis of Table 2, the harvest differences can be observed as compared to the untreated control variant V7, as follows:

- V1 ACANTO PLUS 0.5 L/HA treatment applied at spike's release (01.05.2018) has achieved a harvest of 7.688 t/ha, respectively an increment of 0.323 t/ha as compared to the untreated control variant (V7).
- V2 ACANTO PLUS 0.5 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018) has achieved a harvest of 7.789 t/ha, respectively an increment of 0.424 t/ha as compared to the untreated control variant (V7).
- V3 FALCON 460 EC – 0.7 L/HA 1 treatment applied at spike's release - blooming (1.05.2018) has achieved a harvest of 7.911 t/ha respectively an increment of 0.546 t/ha as compared to the untreated control variant (V7).
- V4 FALCON 460 EC – 0.7 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018) has achieved a harvest of 7.769 t/ha respectively an increment of 0.404 t/ha as compared to the untreated control variant (V7).
- V5 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release - blooming (1.05. 2018) has achieved a harvest of 7.870 t/ha respectively an increment of 0.505 t/ha as compared to the untreated control variant (V7).
- V6 MYSTIC 250 EC 0.5 L/HA 1 treatment applied at “bellows” phase (11.04 2018) + 1 treatment applied at the beginning of kernel's filling (10.05.2018) had achieved a harvest of 7.728t/ha, respectively an increment of 0.363 t/ha as compared to the untreated control variant (V7).

- V7 Untreated control variant had achieved a harvest of 7.365 t/ha.

The harvest differences presented statistical assurance at V3 and V5, distinctly significant (**) and significant at V2, V4 and V6 (*). The harvest increment achieved by V1 (0.323 t/ha) has no statistical assurance, minimally accepted by the experimental technique and must not be taken into consideration.

CONCLUSIONS

The observations performed in the spring of the year 2018 on the barley crop, in the pedoclimatic conditions of the Eastern Baragan had led to the following conditions and recommendations:

1. The most dangerous pathogenic agent of barley had proven to be in 2018 the *Pyrenophora graminea* fungus which produces the disease under the popular name of "leaf stripe". However, the attack of this fungus was more reduced than that of the previous years. The harvest differences between the treated variants and untreated control variant were quite small (maximum 0.546 t/ha at V3).

2. Insignificant attacks of the fungus which attack the foliage, respectively *Blumeria graminis* f.sp. *hordei*- barley's mildew, *Puccinia hordei*-barley's rust and *Rhynchosporium secalis* - brown leaf blotch had been observed.

3. For a secure protection against the attack of the pathogenic agents specific to barley, it is recommended the application, in the difficult years (rainy and chilly), of 2 phytosanitary treatments with fungicides homologated products for barley from the triazoles group, such as: FALCON 460 EC (triadimenole 43 g/l + tebuconazole 167 g/l + spiroxamine 250 g/l) in dosage of 0.7 l/ha and MYSTIC 250 EC (tebuconazole 250 g/l). The first treatment is recommended to be applied in the bellows phase and the second at the beginning of kernel's filling phase. The application of one single treatment in the difficult years is not recommended, because barley is a more sensitive variety than wheat to the attack of specific pathogenic agents.

4. In the years with droughty springs, unfavourable to the attack of the disease, like 2018, one single treatment can be applied at barley's blooming. In the conditions where in 2019 it is foreseen a price of 0.75 lei/kg of barley for beer, the increments of 0.424 t/ha and 0.404 achieved by the variants V2 and V4 (two phytosanitary treatments) are not justified from economic point of view. For example, the price of a liter of FALCON 460 EC is approx. 160 lei/l and is applied in dosages of 0.6 – 0.7 l/ha. One liter of MYSTIC 250 EC costs approx. 120 lei, in the conditions in which 0.5 l/ha is applied for one treatment. ACANTO PLUS product cannot be traded and used in Romania starting with December 2018. The limit date for storage and usage of this product, based on picoxistrobin, was 30.11.2018 according to the Regulation (EU) no. 1455/2017. The harvest increments offered by the variants V3 and V5 to which one single treatment was applied were 0.546 t/ha and respectively 0.505 t/ha. These two variants proved to be the most efficient from economic point of view.

5. Salamandre beer barley variety proved to be quite resistant to the diseases specific to barley, in conditions of 0 treatments with fungicides (V7). This variety achieved a very good harvest (7.365 t/ha) in 2018.

6. The exchange currency Leu/€ for the first 7 months of the year 2018 was 4.7396 lei/1€, according to the Romanian National Bank's website.

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PRELIMINARY RESULTS ABOUT EXPERIMENTAL SUNFLOWER HYBRIDS RESISTANT TO BOTH SULFONYLUREA AND IMIDAZOLINONE HERBICIDE

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Abstract

It is important to choose what herbicide we want to use depending on degree of weed infestation and what type of sunflower hybrid resistant at sulfonilurea or imidazolinone herbicide. Some farmers who cultivated sunflower in South-East of Romania where broomrape is present with the most virulent races, use IMI sunflower hybrids and spray with a IMI herbicide for a better control. Other farmers, prefers SU sunflower hybrids especially in field without broomrape. At NARDI Fundulea, we created sunflower hybrids resistant at sulfonilurea herbicide and sunflower hybrids resistant at imidazolinone herbicide but also we created experimental sunflower hybrids resistant to booth sulfonilurea and imidazolinone herbicide. In year 2018, at NARDI Fundulea, we tested, four experimental sunflower hybrids SU-IMI Plus, H1 SU-IMI Plus, H2 SU-IMI Plus, H3 SU-IMI Plus and H4 SU-IMI Plus, for resistance at sulfonilurea herbicide in Express Sun™ system and imidazolinone herbicide in Clearfield® system. These four experimental sunflower hybrids were full resistant in booth systems, in Express Sun™ and Clearfield®.

Key words: sunflower, herbicide, imidazolinone, sulfonilurea, hybrids

Sunflower is a very important culture in Romanian agriculture and in nowadays on the seed market is three types of sunflower hybrids: conventional hybrids, imidazolinone hybrids (IMI) and sulfonilurea hybrids (SU). The farmers who sowing IMI hybrids in Clearfield® system and SU hybrids in Express Sun™ system, have a good weed control, because, this specific herbicide for this types of hybrids, have a large specter of weed such as annual dicotyledonous weeds and some annual monocotyledons (Al-Khatib K. *et al.*, 2010; Škorić D. *et al.*, 2012; Santos G. *et al.*, 2012).

At NARDI Fundulea, in sunflower breeding program, one main objective, was to introduce genes *Imr1*, *Imr2*, for resistance to imidazolinone herbicide (Alonso L.C. *et al.*, 1998) gene *SU7 Express Sun* for resistance to sulfonilurea herbicide (tribenurrol methyl), gene *CLHA-PLUS* for resistance to imidazolinone herbicide (Sala C.A. *et al.*, 2008).

The degree of weed infestation in fields cultivated with sunflower in Romania is very high and because of that in nowadays is used the technology who integrated sunflower hybrids Clearfield IMI + herbicide imidazolinone Pulsar in dose of 1.2 l/ha or sunflower hybrids SU +

herbicide sulfonilurea Express in dose of 30g/ha (Bozic D. *et al.*, 2015).

The farmers from the region from south-east of Romania, infested with parasite broomrape use herbicide imidazolinone Pulsar (Alonso *et al.*, 1998; Pfening M. *et al.*, 2008; Fernandez-Martinez F.M. *et al.*, 2015).

From 2018, on the Romanian seed market is sunflower hybrids IMI Clearfield Plus with herbicide Pulsar Plus who is less aggressive than herbicide Pulsar 40 (Sala C.A. *et al.*, 2012, Bessai J. *et al.*, 2018).

My idea, was to integrated both genes for resistance at herbicide SU and IMI Plus in the same genotype to create sunflower hybrids SU-IMI Plus and farmers to decide what herbicide to use depending on what weed infestation or presence/absence of parasite broomrape.

MATERIAL AND METHOD

At NARDI Fundulea, in year 2014, I started to introduce gene CLHA Plus from lines sources *BTI-bM1b* and *BTI - R1*, in two elite lines B, ANT 1B SU, ANT 2B and in two elite lines C, ANT1C SU, ANT 2C SU, who are resistant at SU herbicide, belonging to NARDI Fundulea (*figure 1*).

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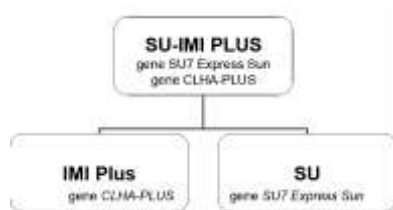


Figure 1 Incorporate gene CLHA PLUS and gene SU7 Express Sun in a SU-IMI Plus sunflower genotype

This two maintainer lines ANT 1B SU, ANT 2B and two restorer lines, ANT1C SU, ANT 2C SU, has already integrated gene for resistance to sulfonilurea herbicide from lines sources *Sures 1* and *Sures 2* (figure 2).

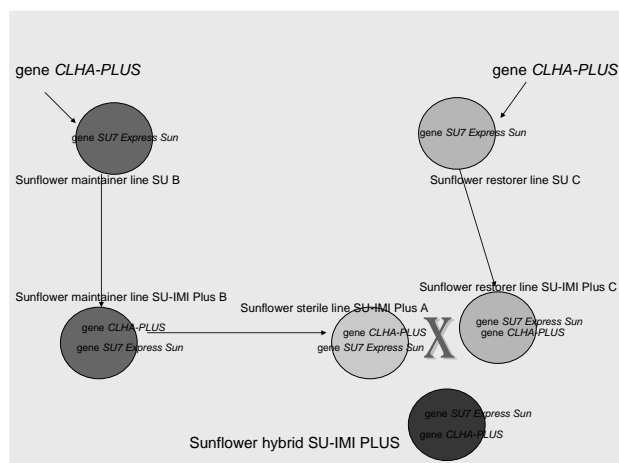


Figure 2 Scheme of obtaining a sunflower hybrid SU-IMI Plus

I make selection from F2 generation of resistant/tolerant/sensible genotype after I sprayed the same genotype with Pulsar 40 in dose of 1.2 l/ha in field IMI in stage of four true leaves and the same genotype with Express 50 in dose of 30 g/ha in field SU at stage of four true leaves.

RESULTS AND DISCUSSIONS

I crossing pollen from two restorer line, ANT 1C SU-IMI Plus and ANT 2C SU-IMI Plus to two female lines, ANT 1A SU-IMI (analog sterile of maintainer fertile line ANT 1B SU-IMI Plus) and ANT 2A SU-IMI (analog sterile of maintainer fertile line ANT 2B SU-IMI Plus) in year 2017 and we obtain in year 2018, four experimental hybrids SU-IMI Plus (figure 3).

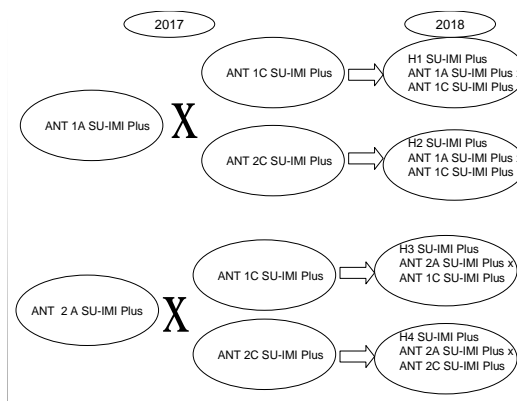


Figure 3 Scheme of obtaining four experimental sunflower hybrids SU-IMI Plus

In year 2018, I make notation about four SU-IMI Plus experimental hybrids tested in SU field and IMI fields for resistance at herbicides (table 1, 2). The four SU-IMI Plus sunflower hybrids was sowing in micro lots of 4 rows and was sprayed with IMI herbicide Pulsar 40 in dose of 1.2 l/ha, who has active substance 40 g/l imazamox, instead Pulsar Plus in dose of 1.6 l/ha, who has active substance 25 g/l imazamox, in IMI field, in Clearfield® system (Bessai J. *et al.*, 2018) and with SU herbicide Express 50 in dose of 30 g/ha who has active substance 50 g/kg tribenurrol methyl, in SU field, in Express Sun™ system.

Table 1
Resistance at herbicide PULSAR 40, of four SU-IMI Plus sunflower hybrids, in IMI field, in Clearfield® system, in year 2018, at NARDI Fundulea

Hybrid combination	Date of sowing	Date of treatment in stage of four true leaves	Observation regarding resistance/sensitivity after 14 days after treatment, in field IMI/2018
H1 SU-IMI Plus ANT 1A SU-IMI Plus x ANT 1C SU-IMI Plus	14.05.2018	5.06.2018	All plants resistant
H2 SU-IMI Plus ANT 1A SU-IMI Plus x ANT 2C SU-IMI Plus	14.05.2018	5.06.2018	All plants resistant
H3 SU-IMI Plus ANT 2A SU-IMI Plus x ANT 1C SU-IMI Plus	14.05.2018	5.06.2018	All plants resistant
H4 SU-IMI Plus ANT 2A SU-IMI Plus x ANT 2C SU-IMI Plus	14.05.2018	5.06.2018	All plants resistant

Table 2

Resistance at herbicide EXPRESS 50, of four SU-IMI Plus sunflower hybrids, in SU field, in Express Sun™ system, in year 2018, at NARDI Fundulea

Hybrid combination	Date of sowing	Date of treatment in stage of four true leaves	Observation regarding resistance\sensitivity after 14 days after treatment, in field SU/2018
H1 SU-IMI Plus ANT 1A SU-IMI Plus x ANT 1C SU-IMI Plus	25.04.2018	23.05.2018	All plants resistant
H2 SU-IMI Plus ANT 1A SU-IMI Plus x ANT 2C SU-IMI Plus	25.04.2018	23.05.2018	All plants resistant
H3 SU-IMI Plus ANT 2A SU-IMI Plus x ANT 1C SU-IMI Plus	25.04.2018	23.05.2018	All plants resistant
H4 SU-IMI Plus ANT 2A SU-IMI Plus x ANT 2C SU-IMI Plus	25.04.2018	23.05.2018	All plants resistant

Plant height of SU-IMI Plus sunflower hybrids, was in Fundulea, in year 2018, in IMI field, in Clearfield® system, in Fundulea, between 158 and 165 cm and in SU field, in Express Sun™ system, was between 135 and 154 cm.

One thousand seed weight (TSW) of SU-IMI Plus sunflower hybrids, was in Fundulea, in year 2018, in IMI field, in Clearfield® system and in SU field, in Express Sun™ system, between 48g and 68g.

Hectolitre weight (kg/hl) was in Fundulea, in year 2018, in IMI field, in Clearfield® system, between 39.1 and 39.9 kg/hl and in SU field, in Express Sun™ system, was between 32.2 and 34.8 kg/hl.

Regarding oil content, H2 SU-IMI Plus have a bigger content then other three hybrids, in field SU, in Express Sun™ system (figure 4).

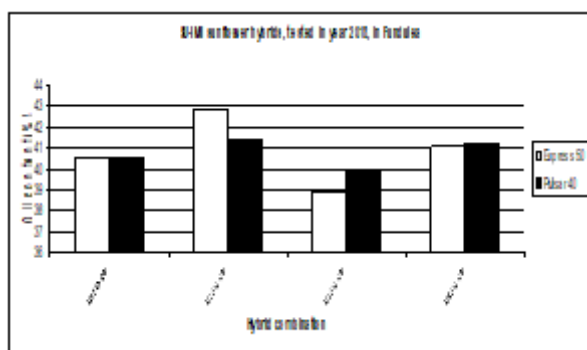


Figure 4 Oil content of SU-IMI Plus sunflower hybrids, in year 2018, in Fundulea

Seed yield (kg/ha) was in Fundulea, in year 2018, in micro lots of four rows, of 7 m long, in IMI field, in Clearfield® system, between 3472 and 4316 kg/ha, when H4 SU-IMI Plus have the best

production of seed and in SU field, in Express Sun™ system, was between 3851 and 4960 kg/ha, when H1 SU-IMI Plus have the best production of seed (figure 5).

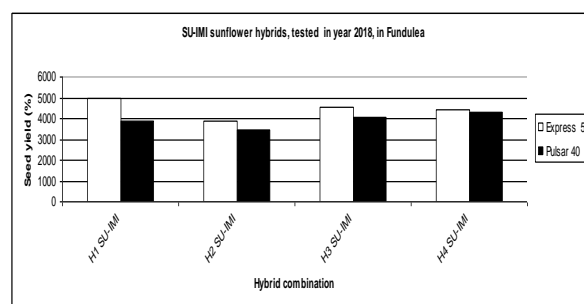


Figure 5 Seed yield of SU-IMI Plus sunflower hybrids, in year 2018, in Fundulea

Protein content (%) was in Fundulea, in year 2018, in IMI field, in Clearfield® system, between 18 and 19.1% and in SU field, in Express Sun™ system, was between 17.2 and 17.7% (figure 6).

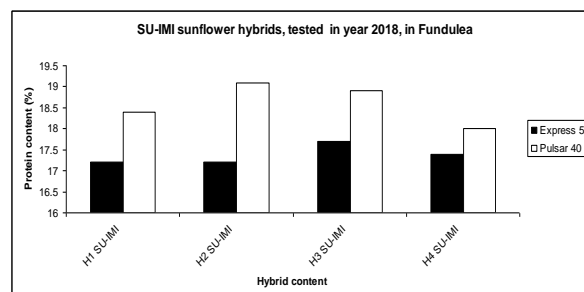


Figure 6 Protein content of SU-IMI Plus sunflower hybrids, in year 2018, in Fundulea

CONCLUSIONS

SU-IMI Plus hybrids, are a new generation of experimental sunflower hybrids who have integrated gene *CLHA-PLUS* for resistance to imidazolinone herbicide and gene *SU7 Express Sun* for resistance to sulfonylurea herbicide.

Farmers who sowing this new type of sunflower hybrids, decide what herbicide to use, depending on what weed infestation have or if broomrape is present/absent.

This very early preliminary result, show us the productive potential of this new experimental SU-IMI sunflower hybrids in a micro lots at density of 50.000 plants/ha, with a maximum seed yield of 4960 kg/ha (H1 SU-IMI Plus) in a technology with SU herbicides, in Express Sun™ system and of 4316 kg/ha (H4 SU-IMI Plus) in a technology with IMI herbicides, in Clearfield® system.

Oil content of 42.8% of H3 SU-IMI Plus in a technology with SU herbicides, in Express Sun™ system and of 41.4 % of H3 SU-IMI Plus in a technology with IMI herbicides, in Clearfield® system, show us, a good oil content of this new experimental sunflower hybrids.

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STUDY REGARDING THE USE OF MULBERRY LEAVES (KOKUSO 21 VARIETY) BY *BOMBYX MORI* (TRIUMF HYBRID)

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Abstract

In order to assess how efficient is the use of Mulberry leaf by the *Bombyx mori* Triumf larvae hybrid, some determinations were made regarding the nutritional value and digestibility of the worm leaf administered as food (leaves from a Japanese variety, Kokuso 21), during a series of summer growth. The results showed that ongoing vegetation and growth process of this hybrid, the Mulberry leaves suffer an aging phenomenon, revealed by diminishing its chemical composition quality. According to this, most of the nutritional substances from Mulberry leaves, except cellulose, manifest a continuous decline during the growth period. The digestibility of these nutritional components registered a value of 55.4%, the raw energy value was 4216 kcal/kg dry substance, the digestive energy was 2156 kcal/kg (DS), while the metabolic energy was 1993-2010 kcal/kg (DS). The efficiency of converting ingestion into silk had a value of 10.1% and the digestion was 17.88%.

Key words: leaves, Mulberry, larvae, energy, use

Besides the continuous improvement of the growth technologies, one of the main concerns of the specialists in sericulture is represented by the production of biological material of high genetic value as the *Bombyx mori* larvae with an increasing productive potential, more resistant to the environmental factors and to diseases and to use nutrients offered by the Mulberry to the best of their advantage.

Thus, from this point of view, the performances of the used larvae in intensive breeding systems have greatly increased, but at the same time, in order for them to be able to reach their full potential, it is necessary to improve all the factors involved in the breeding process. From the multitude of factors that directly influence the growth process of the larvae and the economic results obtained, it is encountered also nutrition.

The quantity and especially the quality of the worm leaf used in feeding of larvae, directly influence the growth rate, their health and vitality, but also the quantitative and qualitative production of silk. In turn, the quality of the leaf is also influenced by many factors related to the pedoclimatic conditions, season, variety of the mulberry, the way of harvesting and storage etc.

In the specific literature, depending on different factors, the relative humidity values of the Mulberry leaf vary between 65-75% (Doliș M., 2008).

Compared with the common Mulberry (69.80-73%), the selected varieties have more water content (Bura M. *et al*, 1995). The dried substance from the worm leaf, harvested in the same period, can record, depending on the variety/hybrid, different values, for example, between 23.61% and 27.56% (Matei A., 1995).

Also, if the spring moisture of the mulberry leaf is 71.85-77.81%, then it decreases to 68.42-75.64%, in the summer period, respectively to 64.10-73.64%, in the fall (Ifrim S., 1998).

Digestibility of the dry substance from the worm leaf decreases from 71.07% in age I, to 39.99% (for male larvae), 48.26% (for female larvae) in age V (Rath S.S. *et al*, 2003). The worm leaf administered to the larvae of the fifth age has an approximate digestibility between 27.99% and 32.44% (Rahmathulla V.K. *et al*, 2002).

The raw leaf protein is estimated to have an average value of 6.16% in the fresh leaf, 20.97% in the dry substance and 24.36% in its organic substance (Doliș M., 2008). The raw leaf protein values can vary depending on the season, the time of day, the variety/hybrid of the dude: 32.40% in spring, 28.21% in summer and 24.53% in autumn (Borcescu A., 1966), 26.80% in the morning and 29.10% in the evening (Mărghițaș L.A., 1995), between 22.55% and 25.73% depending on the variety (Matei A., 1995). In the specialty literature, for raw leaf protein, the value of digestibility

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coefficients is between 69.21% and 78.92 (Borcescu A., 1966), 60.06% and 74.69% (Petkov N., 1980), 71.62% and 93.48% (Matei A., 1995).

The limits presented by specific literature regarding the fat content in mulberry leaves are 2.85- 6.07% (Pop E.C., 1967) The values of the digestibility coefficient for raw fat are between 63.28% and 74.19% (Petkov N., 1980).

According to the data from the specialized literature, in the common Mulberry the weight of the raw cellulose ranges between 12.33-14.38%, while in the different varieties selected oscillates between 10.43-13.70% (Craiciu E., 1966). In the vegetation period of the mulberry the content in raw cellulose from the leaves increases from 14.47% to 21.16% (Pop E.C., 1967). Increased cellulose content causes aging of the worm leaf, which becomes harder and harsher, therefore harder to consume by, which is why those varieties whose leaves have less cellulose content are considered more valuable. At the beginning of the last century, some authors (Acqua, 1930 – cited by Dolis M., 2008) found that the leaf cellulose passes undigested through the digestive tract of the larvae and later it was concluded that this substance has a digestibility of approx. 20% (Legay, 1955 - cited by Dolis M., 2008). Recently, some authors state that in the first two ages, raw cellulose would not be digested, but only from the third (8%), its digestibility reaches 21.13% in the third period (Matei A., 1995).

The values regarding the mineral substances, offered by the specialized literature, ranges between: 9.13-17.38% (Pop E.C., 1967), 11.52-12.80% (Matei A., 1995) and 8.7-13.15% (Bura M. *et al.*, 1995).

At the end of the last century, Romania could be considered an important point on the map of European sericulture. Thus, in her record, Romania can boast in this field with a quite complex literature, as well as with the creation of new varieties and valuable hybrids of worm, as *Bombyx mori*, all being the result of some decade research work of Romanian specialists (Dolis M., 2008; Lazăr S. and Vornicu O.C., 2013; Pătruică S., 2013).

For this reason, we consider appropriate to bring a modest contribution to the study of using the mulberry leaf, derived from indigenous varieties, by larvae of breeds or hybrids created in Romania.

MATERIAL AND METHOD

The biological material used in the experiments was represented by a batch of 150 larvae of *Bombyx mori* from Romanian simple

hybrid *Triumf*. To be easier to follow, the group was divided into three sub-lots (repetitions) of 50 larvae each, which were raised in paper trays sized according to the age and size of the larvae; in addition, it was also made up a separate lot, with 50 larvae reared separately, but under the same conditions, which served to replace the dead larvae from the experimental group.

The growth of the larvae was in August, in an air-conditioned room, in compliance with all the microclimate factors. Each divided group received the same amount of leaf, from the same variety of worm, Kokuso 21, from where samples were previously collected, for chemical analysis.

The variety of mulberry *Kokuso 21* a mulberry variety which derives from the crossing between *Naganua*, *Gariin* and *Shiso* varieties. It is a variety of Japanese origin with whole leaf which has adapted fairly well to the climatic conditions from the south of Romania. In plantations of the intensive type may be produced from the first years a high quantity of leaves with a high protein content.

Daily and at the same time, from each group were collected, weighed and recorded what was not consumed from the Mulberry leaves and what was excreted by the larvae.

The quantities of residues, respectively of excrements, obtained from each group were summed, the result being divided into three, thus obtaining the average quantity of residues from each 50 larvae. The values obtained were subsequently used in the calculation relationships to find the digestibility coefficients. Also, from each group were collected samples of excrements, which were mixed in order to obtain medium samples for analyze.

Also, the groups were weighed at the beginning of growth (after hatching) and at the end (before budding), the difference between the two weights, divided by the number of larvae in each group, representing the increase in body mass accumulated by a larva.

From the separated lot were extracted 10 larvae, whose content was determined in dry matter; thus, multiplying the average dry substance content of larvae, calculated from the separated lots, with the increasing body mass of the larvae in the experimental lots, it was determined the average increasing of body mass of a larva.

After gobbling, 15 cocoons were harvested, from which the silk wrapper was separated, weighed and its dry matter content determined, thus obtaining the average dry wool content of the silk wrapper.

The working methods used were mainly the specific ones used to determine the nutritional value of the worm leaf and they were based on the chemical composition (the "proximate analysis" scheme), the digestibility of its components (the "in vivo" method - simple digestibility, with a single control period) and raw energy (use of specific computation equations and regression coefficients

recommended by the OKIT system), digestible (calculation equation recommended for monogastric species) and metabolizable (equations recommended for monogastric animals and birds) contained (Halga P. *et al*, 2005).

The efficiency of the use of nutrients in the worm leaf by the larvae was expressed by the amount of ingested/digested dry matter required for increasing 1 gram of body mass/weight (silk wrap), respectively by the efficiency of conversion of ingested substances (ECI%)/ digested (ECD%) in body mass/weight (Matei A., 1995; Rahmathulla V.K. *et al*, 2002; Sarkar A., 1993).

RESULTS AND DISCUSSION

Table 1 shows the data of the chemical composition evolution of larvae in relation to their age.

Table 1

The chemical composition evolution of the Kokuso 21 variety mulberry tree leaves during the silkworm larvae growth (%)

The larvae age	Water	DM	CP		EE		CF		NFE		Ash	
			F*	DM**	F*	DM**	F*	DM**	F*	DM**	F*	DM**
I	72.09	27.91	6.31	22.61	0.79	2.83	4.74	16.98	12.33	44.18	3.74	13.40
II	71.66	28.34	6.28	22.16	0.88	3.11	4.88	17.22	12.34	43.54	3.96	13.97
III	70.31	29.59	6.23	21.05	1.14	3.85	5.31	17.95	12.64	42.72	4.27	14.43
IV	70.13	29.87	6.04	20.22	1.16	3.88	5.44	18.21	13.09	43.83	4.14	13.86
V	68.86	31.14	6.15	19.75	1.25	4.01	5.93	19.04	13.41	43.07	4.40	14.13
\bar{x}	70.63	29.37	6.20	21.16	1.04	3.54	5.26	17.88	12.77	43.46	4.10	13.96
$S_{\bar{x}}$	-	0.575	-	0.547	-	0.237	-	0.368	-	0.261	-	0.169
Cv%	-	4.381	-	5.782	-	14.975	-	4.599	-	1.342	-	2.713

* fresh leaves; ** dry matter

The crude protein had an average value of 6.18% ($20.98 \pm 0.670\%$ from DM). It is noticed a progressive decreasing of the protein content throughout the studied period, the content decreasing being with 3.11 percentage points, from 22.14% to 19.03%, respectively.

The fat content from the mulberry leaves was in average 1.10% in the fresh leaves, and $3.70\% \pm 0.260$ in DM. It is the only nutrient with a high variability, of 15.700%. The fat content increased uniformly throughout the silkworm larval growth, from 0.85% to 1.38% when it was expressed in fresh leaves, or 3.2 % to 4.33% respectively, when it was reported to the dry matter.

The crude cellulose was in average 5.31% in fresh leaves, $17.91 \pm 0.434\%$, respectively when it was reported to DM. Throughout the research, for a month, the crude cellulose increased with 2.29 percentage points, from 17.02% to 19.31%, respectively.

The average values obtained for each nutrient separately are set in the limits presented by specific literature, where the data regarding the crude chemical composition of the mulberry leaves varies according to each author, to the research period, to the varieties of mulberry, etc. The average relative humidity of the mulberry leaves during the research was 70.44%, and an decreasing evolution being registered average values between 71.86% (at the first determination corresponding to the first age of the silkworm larvae) and 68.15% (to the last determination when the silkworm larvae are in the age V-th). The dry matter represented $29.56 \pm 0.725\%$.

Nitrogen free extract represented in average $43.27 \pm 0.418\%$ from the dry matter of the mulberry leaves; the average values decreased from the first determination to the third, from 44.17% to 41.95%, then was an increasing to the fourth determination, being 43.89%, decreasing to the last analyses to 42.64%.

The ash represented in average 4.19% in the fresh leaves and $14.15 \pm 0.169\%$ from dry matter. The minerals from the mulberry leaves throughout the research registered a continuous increase from analyse to another. The average values varied from 3.84% to 4.68% to fresh leaves and from 13.65% to 14.69% from dry matter. An exception was registered to the third determination which had a higher value than the fourth one. The increasing in mineral content from mulberry leaves throughout the research was 1.04%.

Knowing the raw chemical composition of the mulberry leaf, using the specific calculation equations, it was possible to assess the nutritional value of the mulberry leaf based on its content of raw energy, which was, on average, over the entire

studied period, of 1245 Kcal/kg, in fresh leaf, respectively 4213 Kcal/kg, in the dry matter (*table 2*).

Table 2

Raw average energy of Mulberry leaf (Kokuso 21 variety)

Specification	%		Caloric equivalent	Kcal/100g		Kcal/100g	
	*	**		*	**	*	**
CP	6.20	21.16	5.72	35.46	121.04	354.6	1210.4
EE	1.04	3.54	9.50	9.88	33.63	98.8	336.3
CF	5.26	17.88	4.79	25.20	85.65	252.0	856.5
NEF	12.77	43.46	4.17	53.25	181.23	532.5	1812.3
						1238	4216

By recording the quantities of the worm leaf administered, the non-consumed and excreted residues and also determining their chemical composition (*table 3*), its digestibility coefficients could subsequently be calculated (*table 4*) and also the content of digestible substances in the leaf (*table 5*).

Following the complex phenomenon of digestion, nutrients are transformed into simple substances, which can thus be absorbed through the epithelium of the digestive tract, at different levels, thus being retained in the organism of silk larvae, representing practically the difference between the amount of substances ingested through food and the amount of appropriate substances

found in droppings. Because not all the substances found in excrement are of dietary origin, some of them are of endogenous origin, which can be obtained by this difference, indicating only apparent digestibility. If you admit the fact that at *Bombyx mori* excretions are also found in their excrement, which complicates the establishment of the digestibility of nutrients in the wormwood even more accurately, the use of the approximate digestibility term seems to be more correct (Miranda J.E. and Takahashi R., 1998; Rahmathulla V.K. *et al*, 2004; Rath S.S. *et al*, 2003; Sabhat A. *et al*, 2011; Tzenov P., 1993).

Table 3

Data needed to calculate digestibility coefficients

The larvae age	Specifi-cation	Quantity (g)	Chemical composition (%/g)					
			DM	CP	EE	CF	NEF	Ash
I	Frunză	15.5	27.91	6.31	0.79	4.74	12.33	3.74
	Resturi	5.01	63.82	14.04	2.01	14.59	25.97	7.21
	Excretă	0.16	66.15	21.87	5.67	2.33	27.21	9.07
II	Frunză	26	28.34	6.28	0.88	4.88	12.34	3.96
	Resturi	8.22	60.02	12.01	2.11	14.88	21.01	10.01
	Excretă	0.98	64.69	14.93	3.64	4.31	27.85	13.96
III	Frunză	77	29.59	6.23	1.14	5.31	12.64	4.27
	Resturi	23.14	58.39	10.78	2.31	15.99	22.12	7.19
	Excretă	4.12	65.15	14.99	2.63	7.99	25.53	14.01
IV	Frunză	242	29.87	6.04	1.16	5.44	13.09	4.14
	Resturi	67.93	59.53	12.62	2.45	14.49	24.72	5.25
	Excretă	19.88	63.52	11.01	2.02	14.09	24.99	11.41
V	Frunză	1000	31.14	6.15	1.25	5.93	13.41	4.4
	Resturi	269.02	56.73	11.46	1.88	13.66	23.97	5.76
	Excretă	122.39	61.03	9.98	3.22	13.99	25.01	10.19

During the whole period studied, the digestibility of the dried substance from the worm leaf had a digestibility of 55.40%. The highest digestibility was recorded in larvae of age I

(90.63%), after which, by the end of the larval period, there was a decrease of 37.67percent.

The raw protein had a digestibility coefficient for the entire studied period of 61.93%. The raw protein digestibility decreased

progressively during the studied period, with 27.09%, respectively from 87.26%, in the first larval age, to 60.17%, in the last one. The high digestibility of age I could be explained by the rich content in amides, simple nitrogenous substances,

which are found in the young leaf and which are digested much easier than the protein nitrogenous substances, which have the weight in the old leaf.

Table 4

Digestibility coefficients of Triumf hybrid					
The larvae age	DM	CP	EE	CF	NEF
I	90.63	87.26	58.26	-	92.87
II	73.96	77.34	35.56	7.66	81.58
III	71.05	73.18	68.42	15.29	77.21
IV	60.35	63.79	64.86	15.67	66.63
V	52.96	60.17	47.05	24.08	56.03
I-V	55.40	61.93	50.08	22.85	59.49

The raw fat from the worm leaf had the minimum digestibility value of 35.56%, in the larvae of the second age and maximum of 68.42%, in the larvae of the third age. The results of the digestibility tests regarding the raw fat in the worm leaf are generally inconclusive, as many of these can come from the intestine of the larvae and not from the leaf, which is why, we cannot speak of a determination of the digestibility of the fat itself but of the "ethereal extract", which also contains very large quantities of pigments. Thus, the big differences regarding the evolution of the digestibility of the raw fat during the studied period could be explained.

During the whole larval period, the digestibility of the raw cellulose from the mulberry leaf was 22.85%, null in age I, after which it increased progressively, reaching the end of the period studied up to the value of 24.08%. This increase in the digestibility of raw cellulose, as the larvae grow older, is in line with the development of the enzymatic equipment in their digestive tract. Thus, if at age I, in the digestive tract of the larvae, the enzymes involved in the process of cellulose

digestion are as non-existent, then they gradually increase, reaching the peak at age V, at which point the weight of raw cellulose from the worm leaf it is also bigger. This aspect, however, negatively influences the digestibility of the raw leaf protein, which during the same period, is experiencing a reduction.

Unclaimed extractive substances from the worm leaf had a digestibility over the entire studied period of 59.49%, the digestibility coefficients registering decreasing values, from 92.87%, in the case of the larvae of age I, at 56.03%, in the case of those of fifth age.

Knowing the value of digestibility coefficients, it was possible to calculate the digestible content for each nutrient separately, then the content of digestible substances in the leaf, so when the report was made to the fresh leaf, 138.1 g of Total Digestive Substance/kg were obtained, and when the report was made on the dried substance from the leaf of the mulberry, its nutritional value was 470.33 g TDS/kg (table 5).

Table 5

The nutritional value calculation of the mulberry leaves (g TDS/kg) and digestive energy										
Specification	Raw chemical composition %		Digestibility coefficients	Digestive content %		g Total Digestive Substance /kg		Caloric equivalent (Kcal/g)	Kcal/kg	
	*	**		*	**	*	**		*	**
CP	6.2	21.16	61.93	3.84	13.10	38.40	131.04	5.78	221.95	757.18
EE	1.04	3.54	50.08	0.52	1.77	11.72	39.89	9.42	48.98	166.73
CF	5.26	17.88	22.85	1.20	4.09	12.02	40.86	4.40	52.80	179.96
NEF	12.77	43.46	59.49	7.60	25.85	75.97	258.54	4.07	309.32	1052.10
Total						138.10	470.33		633.06	2155.97

* Reported to the fresh leaves; ** reported to DM

The determination of the digestible energy content of the worm leaf administered in the feed of silk larvae was made based on the relative digestible content of the nutrients contained in it, using the calorific equivalents recommended for monogastric animal species (*table 5*). In the case of the fresh leaf, the digestible energy content was 633 Kcal/kg, and in the case of the dry substance, 2156 Kcal/kg.

The calculation of the metabolic energy from the worm leaf administered in the feed of silk larvae was done by multiplying the digestible content of each nutrient with the energy equivalents recommended for monogastric (pig) animal species. Considering, however, the specificity of the silkworm's digestion, respectively

the similarity with the digestion of the birds, for the estimation of the metabolic energy from the worm leaf, the energetic equivalents recommended for the birds were used (*table 6*).

The average content in metabolic energy from the fresh mulberry leaf was 590 Kcal/kg, when the recommended energy ratios for pigs were used, respectively 585 Kcal/kg, when the recommended coefficients for birds were used. In relation to the dry matter of the leaf, the content in metabolic energy was on average 2010 Kcal/kg, when the recommended energy coefficients for pigs were used, and 1993 Kcal/kg, when the recommended coefficients for birds were used.

Table 6

Metabolic energy of Mulberry leaf

Specification	Digestive content %		Caloric equivalent (Kcal/g)		Kcal/kg			
	*	**			*		**	
			swine	birds	swine	birds	swine	birds
CP	3.84	13.1	5.01	4.26	192.38	163.58	656.31	558.06
EE	0.52	1.77	8.93	9.50	46.44	49.40	158.06	168.15
CF	1.2	4.09	3.44	4.23	41.28	50.76	140.70	173.01
NEF	7.6	25.85	4.08	4.23	310.08	321.48	1054.68	1093.46
					590.18	585.22	2009.75	1992.67

* Reported to the fresh leaves; ** reported to DM

In order to determine the efficiency of use of the nutrients in worm leaf by the silk larvae, except for the intake and digestion, which were calculated during the course of the digestibility tests, it was necessary to determine the average growth rate of the larvae and the mass of the silk shell. The data necessary for calculating the efficiency of the use of the worm leaf by the larvae, as well as the results obtained in this respect, were centralized in table 7.

From the data of this table it is observed that in the case of the *Bombyx mori* Triumf larvae hybrid, for every gram of silk wrap is required 10.1 grams of dry matter ingested from the wormwood, respectively 5.59 grams of digested dry matter, resulting in an efficiency of conversion of silk intake (CEI) of 9.9%, respectively of digestion (CED) of 17.88%

Table 7

Efficiency of using Mulberry leaf by *Bombyx mori* Triumf larvae hybrid

Average body mass gained during the whole larvae stage (g)	Living larvae	5.222
	Dry matter	0.921
Silky shell mass (g Dry Matter)		0.403
Dry Matter of ingested leaf (g)		4.069
Dry Matter of digested leaf (g)		2.254
Ingested Dry Matter/Body mass Dry Matter (g)		4.417
Dry matter ingested/ Body mass Dry Matter (g)		2.447
Dry matter ingested/Silky shell Dry Matter (g)		10.097
Dry matter digested/ Silky shell Dry Matter (g)		5.593
CEI body mass %		22.64
CED body mass %		40.87
CEI silky shell %		9.90
CED silky shell %		17.88

The data obtained from the experience performed, regarding the efficiency of the use of the mulberry leaf by the larvae of *Bombyx mori*, are comparable with those presented in the literature (Matei A., 1995; Rahmathulla V.K. *et al*, 2002; Rath S.S. *et al*, 2003; Sarkar A., 1993; Tzenov P., 1993).

CONCLUSIONS

From those mentioned in the paper, the following conclusion may be drawn:

- Expressed to dry matter from the mulberry leaves, Kokuso 21 variety the average values were: CP – 21.16%, EE – 3.54%, CF – 17.88%, NEF – 43.42% and ash – 13.96%.

- At once with vegetation advancement and implicitly during each growth period of silkworm larvae, the mulberry leaf ages and its quality from the chemical composition point of view is decreasing.

- During the 30 days of the research, was noticed a decreasing of the moisture with 3.23% and of the CP with 2.86 % and in the same time an increasing of the CF with 2.06%.

- During the whole period studied, the digestibility of the dried substance from the worm leaf had a digestibility of 55.40%. The dry matter digestibility decreased with 37.67%.

- Digestibility coefficients of the CP (61.93%) and of the NFE (59.49%) from the mulberry leaves decreased during the study with 27.09% and 36.84%, respectively.

- The CF digestibility, null at the beginning, increased progressively till the fifth larval stage when it was 24.08%.

- Nutritional value of the mulberry leaves was 470 g TDN/ kg DM.

- Throughout the studied period, the gross enrichment of the worm leaf was on average 4216 Kcal/kg, in the dry substance

- In the leaf, the content of digestible energy was, in the case of dry matter, 2156 Kcal/kg.

In relation to the dry matter of the leaf, the content in metabolic energy was on average 1993-2010 Kcal/kg.

In the case of the Triumf hybrid, for each gram of silk wrap, 10.1 grams of dry matter ingested from the mulberry tree are required, respectively 5.59 grams of digested dry substance, resulting an efficiency of conversion of ingestion (CEI) into silk of 9.90%, respectively of the digestion (CEI) of 17.88%

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ADDITIONS TO THE ORIBATID MITES FAUNA (ACARI, SARCOPTIFORMES, ORIBATIDA) AND THEIR COMMUNITY STRUCTURE IN THE DANUBE DELTA BIOSPHERE RESERVE

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Abstract

The present study is part of some recent ecological investigations carried out in the Danube Delta Biosphere Reserve in order to assess the risks to biodiversity and the impact of natural and anthropogenic factors on characteristic ecosystems. Meadows and agro-ecosystems have been taken into study, aiming to investigate qualitatively and quantitatively the oribatid communities, diversity and distribution of species depending on the type of habitat.

In terms of fauna 60 species have been identified belonging to 43 genera and 31 families of the suborder Oribatida Dugès, 1834. The family Ctenacaridae Grandjean, 1954, genera *Ctenacarus* Grandjean, 1939 *Exochocephus* Woolley and Higgins, 1968, also the species *Ctenacarus araneolus* (Grandjean, 1932), *Exochocephus laticuspis* (Balogh and Mahunka, 1965) and *Oribatula (Zygoribatula) andrianovae* (Bulanova-Zachvatkina, 1967) were recorded for the first time in Romanian fauna.

The global average abundance and number of species varies widely from one sampling site to another, even in the case of similar ecosystems. However, in the non-grazing meadows, generally higher values of these parameters were observed compared to cultivated soils and pastures. From a qualitative point of view, notable differences were observed in the species composition of the oribatid communities in meadows and crops, even if they were located in the immediate vicinity. On the other hand, a degree of similarity was noted in the species composition and structure of oribatid coenoses in the agro-ecosystems, regardless of the type of crop and soil.

Key words: oribatid mites, diversity, meadow, agro-ecosystem, wetland

Danube Delta Biosphere Reserve (DDBR) is recognized as one of the places with highest biodiversity in the world. On its territory two of the European bioregions are found - the Pontic and the Steppe one, hence some particular features of both flora and fauna. The deltaic biome comprises various natural habitats, most of them protected at the European Union level within the Natura 2000 network, and besides some anthropogenic habitats (Nicula G. *et al*, 2012; Gâștescu P., 2009). The management of this wetland of international interest is focused on the conservation of the natural heritage, but it must at the same time take into account the vulnerabilities and risks induced by human activities (Gâștescu P., Driga B., 2005).

On the other hand, oribatid mites have little capacity to respond numerically to short-term environmental alterations, because of their low metabolic rates, slow development, and low fecundity (Behan-Pelletier, 1999), thus the agroecosystems are not favorable environment for these microarthropods.

Based on these premises, but also on the results of previous research (Vasiliu N. *et al*, 1994;

Vasiliu N., Ivan O., 1995) the present study aims to update the knowledge of the fauna and the oribatid communities in some characteristic ecosystems of the Danube Delta, as well as to investigate the possible influence of agricultural practices on the surrounding natural ecosystems. The study was conducted as part of an extensive ecological research carried out both in some core areas under full protection regime, as well as in economic zones of DDBR.

MATERIAL AND METHOD

Field research and sampling was carried out in the period 2015-2018 in 10 localities on the territory of the DDBR (Tulcea county), both in natural and anthropogenic ecosystems (*table 1*).

Series of 100 cm² soil samples have been taken over in each sampling site – 130 samples in all. Edaphic mesofauna has been extracted from samples through the Tullgren - Berlese method (the variant proposed by Balogh, 1958) and selected by systematic groups. The oribatid mites were subjected to microscopic study, in order to identify the species. The abundance of species

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was noted in each sample, and immature oribatids were globally counted. The primary data thus obtained have been processed using some analytic and synthetic ecological estimators: average abundance of each species (\bar{a}) and global average abundance (\bar{A}), expressed as individuals/100cm² and, respectively, m²; number of taxa – families (F), genera (G), species (S); average number of species/sample (S') frequency (C) and relative density (D.r.) of each species; index of ecological significance (W), expressed as classes: V and IV-edifying species, III-influential species, II and I-accompanying species; specific diversity (H(s)max, H(s), H.r.), estimated by the Shannon - Wiener equation; the adults/juvenile ratio.

The faunistic list of oribatid mites follows mainly the classification of Subías (Subías L. S., 2004, updated version 2019) and includes autecological peculiarities (according to Mahunka S., Mahunka-Papp L., 2004; Subías L. S., Arillo A., 2001; Vasiliu N. et al., 1993; Weigmann G., 2006) and world distribution of each species (Subías L. S., 2004, updated version 2019). Also, for each species is pointed the occurrence in different sampling sites (locality indicated by the corresponding number, and habitat type abbreviated as in table 1), as well as ecological significance, as follows: +++ edifying species, ++ influential species, + accompanying species; * indicates first record in Romanian fauna.

Table 1

Location of sampling sites			
Locality	Coordinates	Habitat type (abbreviation)	Sampling dates
1. Letea bank (near Hășmacul Mare forest) #	45°18'53" N 29°34'22" E	mesophilous meadow (mm) #	22.07.2015
			11.05.2016
	45°18'54" N 29°33'18" E	meadow between dunes (dm) #	11.05.2016
2. Chilia Veche	45°18'51" N 29°14'09" E	maize (m)	10.05.2016
	45°22'46" N 29°14'22" E	rape (r)	10.05.2016
3. Tătaru Islet	45°18'39" N 29°03'27" E	wheat (w)	10.05.2016
4. Pardina	45°19'33" N 28°58'01" E	barley (b)	10.05.2016
5. Beștepe	45°05'15" N 29°02'27" E	xerophilous meadow (xm)	12.07.2018
		maize (m)	12.07.2018
		sunflower (s)	12.07.2018
		rape (r)	12.07.2018
6. Murighiol #	45°01'41" N 29°09'32" E	halophilous meadow (hm)#	09.05.2016
			13.07.2018
	45°01'55" N 29°08'12" E	barley (b)	06.06.2017
		sunflower (s)	13.07.2018
7. Plopu	45°01'23" N 29°06'34" E	lucerne (l)	13.07.2018
		halophilous meadow (hm) - pasture	13.07.2018
		wheat (w)	07.06.2017
			13.07.2018
8. Sarinasuf	45°00'51" N 29°04'53" E	halophilous meadow (hm) - pasture	13.07.2018
		lucerne (l)	07.06.2017
			13.07.2018
		sunflower (s)	07.06.2017
9. Sarichioi	44°55'35" N 28°6'13" E	wheat (w)	13.07.2018
		pea (p)	07.06.2017
10. Enisala	44°52'42" N 28°49'7" E	xerophilous meadow (xm)	23.09.2015

Legend: # fully protected areas

RESULTS AND DISCUSSIONS

Investigation on the oribatid mite fauna resulted in identification of 60 species belonging to 43 genera and 31 families of the suborder Oribatida Dugès, 1834, as listed below:

Fam. Ctenacaridae Grandjean, 1954*

Ctenacarus Grandjean, 1939*

-*C. araneolus* (Grandjean, 1932)*: 8-s (+); prefers forest humus; pantropical, subtropical

Fam. Brachychthoniidae Thor, 1934

Brachychthonius Berlese, 1910

-*B. pius* Moritz, 1976: 5-xm (+); silvicolous, xerophilous; Holarctic

Liochthonius (*Liochthonius*) Hammen, 1959

-*L. (L.) sellnicki* (Thor, 1930): 1-dm (+), 5-xm (+); eurytopic, prefers forest soils; Holarctic, SE China

-*L. (L.) simplex* (Forsslund, 1942): 6-hm (+); silvicolous species; semi-cosmopolitan

Poecilochthonius Balogh, 1943

- *P. italicus* (Berlese, 1910): 6-hm (+); meso-xerophilous; Holarctic

Sellnickochthonius Krivolutsky, 1964

- *S. immaculatus* (Forsslund, 1942): 2-m (+), 5-xm (+), 6-hm (++), 7-hm (+); eurytopic, prefers forest soils; Holarctic, Neotropical

Fam. Cosmochthoniidae Grandjean, 1947

Cosmochthonius (*Cosmochthonius*) Berlese, 1910

- *C. (C.) lanatus* (Michael, 1885): 8-l (+); eurytopic, xerophilous; cosmopolitan

Fam. Haplochthoniidae Hammen, 1959

Haplochthonius (*Haplochthonius*) Willmann, 1930

- *H. (H.) simplex* (Willmann, 1930): 5-m (++), 9-p (++); recorded in dry, xerothermic habitats; semi-cosmopolitan

Fam. Sphaerochthoniidae Grandjean, 1947

Sphaerochthonius Berlese, 1910

- *S. splendidus* (Berlese, 1904): 5-xm (+++), 10-xm (+); thermo-xerophilous; pantropical

Fam. Lohmanniidae Berlese, 1916

Lohmannia (*Lohmannia*) Michael, 1898

- *L. (L.) turcmenica* Bulanova-Zachvatkina, 1960: 8-s (+), 8-w (+); xerophilous; tropical (SE China, Argentina, S Palaearctic)

Fam. Epilohmanniidae Oudemans, 1923

Epilohmannia Berlese, 1910

- *E. cylindrica* (Berlese, 1904): 3-w (+++), 4-b (++), 5-xm (++), 6-b (++), 6-l (+++), 6-hm (+), 7-w (++), 8-l (+), 8-s (++), 8-w (+++), 9-p (++); eurytopic, grassland species; cosmopolitan

Fam. Euphthiracaridae Jacot, 1930

Acrotritia Jacot, 1923

- *A. ardua* (Koch, 1841): 6-l (++), 8-l (+); mainly silvicolous, eurytopic; cosmopolitan

Fam. Crotoniidae Thorell, 1876

Heminothrus (*Platynothrus*) Berlese, 1913

- *H. (P.) peltifer* (Koch, 1839): 6-hm (+); eurytopic, mesophilous, salt tolerant; semi-cosmopolitan

Fam. Neoliodidae Sellnick, 1928

Poroliodes Grandjean, 1934

- *P. farinosus* (Koch, 1839): 5-xm (+++); silvicolous; Palaearctic, Nepal

Fam. Gymnodamaeidae Grandjean, 1954

Adrodamaeus Paschoal, 1984

- *A. siculus* (Berlese, 1910): 5-xm (++); South and Central Europe

Fam. Damaeidae Berlese, 1896

Belba Heyden, 1826

- *B. (B.) dubinini* Bulanova-Zachvatkina, 1962: 3-w (+), 5-xm (+), 8-l (+); Palaearctic

Fam. Liacaridae Sellnick, 1928

Birsteinus Krivolutsky, 1965

- *B. clavatus* Krivolutsky, 1965: 5-xm (++); in Romania occurs in dry, xerothermic habitats; European part of Russian Federation, Romania

Liacarus (*Liacarus*) Michael, 1898

- *L. (L.) coracinus* (Koch, 1841): 5-xm (+); eurytopic; Palaearctic, Ethiopian

Liacarus (*Dorycranosus*) Woolley, 1969

- *L. (D.) punctulatus* Mihelčič, 1956: 6-hm (+); in Romania recorded mostly in grasslands; Palaearctic

Fam. Oppiidae Sellnick, 1937

Graptoppia (*Graptoppia*) Balogh, 1983

- *G. (G.) cf. neonominata* Subías, 2004: 4-b (+++), 5-xm (+); xerophilous, euedaphic; Ethiopian, S Palaearctic

Multioppia (*Hammeroppia*) Vasiliu et Ivan, 2009

- *M. (H.) moritzi* Mahunka et Topercer, 1983: 2-m (+++), 2-r (+++), 3-w (+++), 4-b (++), 6-b (+++), 6-l (++), 6-s (+++), 6-hm (+), 7-w (+++), 9-p (++); recorded in cultivated soils; Central Europe

Ramusella (*Ramusella*) Hammer, 1962

- *R. (R.) clavipectinata* (Michael, 1885): 5-r (+), 5-xm (+++), 8-l (++), 8-s (+), 8-w (+); eurytopic; semi-cosmopolitan

- *R. (R.) sengbuschi tokyoensis* (Aoki, 1974): 5-xm (++), 6-b (++), 6-s (+++), 7-w (+++), 10-xm (+); recorded mostly in cultivated soils; S Palaearctic

Ramusella (*Insculptoppia*) Subías, 1980

- *R. (I.) elliptica* (Berlese, 1908): 2-m (+++); recorded in various habitats, halophilous; tropical and subtropical

- *R. (I.) insculpta* (Paoli, 1908): 1-dm (+); eurytopic, thermo-xerophilous; Palaearctic, Vietnam

- *Ramusella (I.)* sp.: 2-m (+), 4-b (++), 8-l (++), 8-s (++), 8-w (+++)

Micropoppia Balogh, 1983

- *M. minus minus* (Paoli, 1908): 1-dm (+), 2-r (++), 6-s (+), 6-hm (++), 8-w (+), 10-xm (+); eurytopic, euedaphic; cosmopolitan

Rhinoppia (*Rhinoppia*) Balogh, 1983

- *R. (R.) obsoleta obsoleta* (Paoli, 1908): 2-m (+); eurytopic; Palaearctic, Greenland, Australia

- *R. (R.) oblongata* Gordeeva et Melamud, 1991: 3-w (+); SE Europe

Oppiella (*Oppiella*) Jacot, 1937

- *O. (O.) nova nova* (Oudemans, 1902): 3-w (++); eurytopic; cosmopolitan

Corynoppia Balogh, 1983

- *C. kosarovi* (Jeleva, 1962): 5-xm (+); Mediterranean, Iran, Panama

Fam. Suctobelbidae Jacot, 1938

Suctobelbella (*Suctobelbella*) Jacot, 1937

- *S. (S.) subcornigera subcornigera* (Forsslund, 1941): 3-w (+); eurytopic; semi-cosmopolitan

Fam. Tectocephidae Grandjean, 1954

Tectocephus Berlese, 1896

- *T. velatus* (Michael, 1880): 1-mm (+++), 1-dm (+), 5-xm (+++), 6-l (++), 6-hm (+++); eurytopic; cosmopolitan

Fam. Scutoverticidae Grandjean, 1954

Exochocephus Woolley et Higgins, 1968*

-*E. laticuspis* (Balogh et Mahunka, 1965)*: 1-dm (+++); S Palaearctic

Scutovertex Michael, 1879

-*S. sculptus* Michael, 1879: 1-mm (++), 1-dm (++), 5-xm (+), 7-hm (++), 8-l (+); eurytopic, grassland species, salt tolerant; Palaearctic, New Zealand

Fam. Passalozetidae Grandjean, 1954

Bipassalozetes (*Bipassalozetes*) Mihelčič, 1957

-*B. (B.) reticulatus* (Mihelčič, 1957): 1-mm (+++), 10-xm (+++); xerophilous; S Palaearctic

Fam. Phenopelopidae Petrunkevitch, 1955

Peloptulus (*Peloptulus*) Berlese, 1908

-*P. (P.) montanus* Hull, 1914: 1-mm (+), 1-dm (+), 6-hm (+), 7-hm (+++); recorded in fresh and moist meadows; Palaearctic

-*P. (P.) phaenotus* (Koch, 1844): 5-xm (+); eurytopic, grassland species, salt tolerant; Palaearctic

Fam. Microzetidae Grandjean, 1936

Berlesezetes Mahunka, 1980

-*B. ornatissimus ornatissimus* (Berlese, 1913): 8-l (+), 8-s (+), 8-w (+); pantropical, subtropical

Fam. Tegeribatidae Grandjean, 1954

Tectoribates Berlese, 1910

-*T. ornatus* (Schuster, 1958): 2-m (+++), 6-b (++), 7-hm (++), 8-l (+++), 8-hm (+); thermo-xerophilous, grassland species, salt tolerant; Palaearctic, Neotropical

Fam. Oribatellidae Jacot, 1925

Oribatella (*Oribatella*) Banks, 1895

-*O. (O.) reticulata* Berlese, 1916: 1-mm (+); silvicolous; S Holarctic

Fam. Ceratozetidae Jacot, 1925

Trichoribates (*Trichoribates*) Berlese, 1910

-*T. (T.) berlesei* (Jacot, 1929): 10-xm (++); xerophilous, arboricolous, muscicolous; Holarctic, Cambodia

Trichoribates (*Latilamellobates*) Shaladybina, 1971

-*T. (L.) incisellus incisellus* (Kramer, 1897): 1-mm (+), 5-xm (+); grassland species; Holarctic

-*T. (L.) naltshicki* (Shaladybina, 1971): 1-dm (+), 6-b (+), 10-xm (+); thermo-xerophilous, grassland species; E Mediterranean, SE Palaearctic

Zetomimus (*Protozetomimus*) Perez – Iñigo, 1990

-*Z. (P.) acutirostris* (Mihelčič, 1957): 1-mm (+), 3-w (+++), 4-b (+), 7-w (+), 8-w (++), 9-p (+++); grassland species; Mediterranean

Fam. Chamobatidae Thor, 1937

Hypozetes Balogh, 1959

-*H. bulgaricus* Jeleva, 1962: 8-l (+++); S Europe, India

Fam. Humerobatidae Grandjean, 1971

Humerobates Sellnick, 1928

-*H. rostromellatus rostromellatus* Grandjean, 1936: 7-hm (+++), 8-l (+), 8-hm (+++); arboricolous, halophilous; semi-cosmopolitan

Fam. Punctoribatidae Thor, 1937

Punctoribates (*Punctoribates*) Berlese, 1908

-*P. (P.) minimus* Shaladybina, 1969: 1-mm (++), 6-hm (+++); S Palaearctic

-*P. (P.) punctum* (Koch, 1839): 6-l (++), 6-s (+), 7-w (+); eurytopic, grassland species; semi-cosmopolitan

Fam. Oribatulidae Thor, 1929

Oribatula (*Oribatula*) Berlese, 1895

-*O. (O.) amblyptera* (Berlese, 1916): 2-m (+), 2-r (++); meso-hygrophilous; Central and South Europe

Oribatula (*Zygoribatula*) Berlese, 1916

-*O. (Z.) andrianovae* (Bulanova-Zachvatkina, 1967)*: 1-mm (+++), 1-dm (++), 7-hm (++); South of European Russia, Mongolia

-*O. (Z.) connexa connexa* Berlese, 1904: 3-w (++), 4-b (+++), 5-m (+++), 5-s (+), 5-r (+++), 5-xm (+), 8-l (++); eurytopic, recorded in cultivated soils; Mediterranean

-*O. (Z.) undulata* Berlese, 1916: 1-mm (+), 6-b (++), 6-hm (+++), 8-hm (+); xerophilous, halophilous; pantropical, subtropical

Fam. Hemileiidae J. et P. Balogh, 1984

Hemileius (*Urubambates*) Hammer, 1961

-*H. (U.) romanicus* (Vasiliu et Călugăr, 1981): 10-xm (+); xerophilous; Romania

Fam. Scheloribatidae Grandjean, 1933

Scheloribates (*Scheloribates*) Berlese, 1908

-*S. (S.) fimbriatus fimbriatus* Thor, 1930: 8-hm (+++); recorded in meadows, in cultivated soils; pantropical, subtropical

-*S. (S.) labyrinthicus labyrinthicus* Jeleva, 1962: 1-mm (+++), 3-w (++), 5-xm (+++), 6-b (+++), 6-l (++), 6-s (+), 6-hm (+++), 7-hm (+++), 8-l (+++), 8-s (+), 8-hm (+++), 10-xm (+++); eurytopic, grassland species; S Palaearctic

-*S. (S.) pallidulus* (Koch, 1841): 1-mm (+++), 1-dm (+++), 3-w (++), 5-r (+), 6-b (++), 6-l (++), 6-s (+++), 7-w (++), 8-l (++), 8-s (+++), 8-w (++), 9-p (++); eurytopic; cosmopolitan

Fam. Protoribatidae J. et P. Balogh, 1984

Protoribates (*Protoribates*) Berlese, 1908

-*P. (P.) capucinus capucinus* Berlese, 1908: 2-m (+++), 4-b (+), 6-b (+++), 6-l (++), 6-s (++), 8-w (+); eurytopic, mesophilous; cosmopolitan

Fam. Galumnidae Jacot, 1925

Pergalumna (*Pergalumna*) Grandjean, 1936

-*P. (P.) nervosa* (Berlese, 1914): 1-mm (+), 5-xm (+); eurytopic, mesophilous; Holarctic

-*P. (P.) obvia* (Berlese, 1914): 6-hm (+++); eurytopic, mesophilous; semi-cosmopolitan.

As can be noted in the list of fauna, the family Oppiidae is best represented as number of taxa (7 genera, 12 species), followed by Brachychthoniidae (4 genera, 5 species). Furthermore, some oppiid species are widely

distributed, being present in many of the investigated sites, alongside of representatives of the families Scheloribatidae and Oribatulidae. Zoogeographical analysis of the oribatid fauna shows that cosmopolitan and semi-cosmopolitan elements are the most numerous (33.3% of the total number of species), followed by the Palaearctic (23.3%), the European (16.7%), and Holarctic species (13.3%). The species with southern distribution represent about 1/3 of the total number, noteworthy being the high share of pantropical and subtropical species (11.7%).

In terms of ecological spectrum the eurytopic, less exigent species, besides those that prefer grassland soils represent the most numerous groups (each representing 23.3% of the total number of species), followed by sylvicolous species (13.3%). Noteworthy is that xerophilous or thermo-xerophilous species represent about 25% of

the total, which illustrates the peculiarity of fauna in this region.

In this context the family Ctenacaridae Grandjean, 1954, the genera *Ctenacarus* Grandjean, 1939 and *Exochocepheus* Woolley and Higgins, 1968, and also the species *Ctenacarus araneolus* (Grandjean, 1932), *Exochocepheus laticuspis* (Balogh and Mahunka, 1965) and *Oribatula* (*Zygoribatula*) *andrianovae* (Bulanova-Zachvatkina, 1967) are recorded for the first time in Romanian fauna (Vasiliu *et al.*, 1993). In addition some rare species were identified e.g., *Lohmannia* (L.) *turcmenica* Bulanova-Zachvatkina, 1960, *Birsteinus clavatus* Krivolutsky, 1965, *Corynoppia kosarovi* (Jeleva, 1962), *Berlesezetes ornatus* (Berlese, 1913), *Hypozetes bulgaricus* Jeleva, 1962, *Hemileius* (U.) *romanicus* (Vasiliu et Călugăr, 1981), some of them recorded only in Dobrogea (Vasiliu N. *et al.*, 1993).

Table 2

Structural parameters of the oribatid mite communities

Locality*/ sampling site / date			Ā		Number of taxa (F/G/S)	S'	Adults/ immatures	Specific diversity		
			total	adults				H(s) _{max}	H(s)	H.r.
1	mesophilous meadow	22.07.2015	2820	2300	9/9/11	5.7	4.42	3.4594	2.5492	73.69
		11.05.2016	2420	2200	8/9/9	4	10	3.1699	1.8686	58.94
	meadow between dunes	11.05.2016	4520	4300	8/10/10	4.2	19.5	3.3219	1.3324	40.11
2	maize	10.05.2016	3700	3460	5/7/8	4.6	14.4	2.9999	1.8951	63.17
	rape	10.05.2016	120	120	2/3/3	0.8	-	1.5849	1.251	78.93
3	wheat	10.05.2016	840	820	7/9/10	4.4	41	3.3219	2.902	87.36
4	barley	10.05.2016	1480	1280	5/7/7	3	6.4	2.8073	1.9081	67.97
5	xerophilous meadow	12.07.2018	17340	13780	15/21/22	11.8	3.9	4.4594	3.0399	68.17
	maize	12.07.2018	120	120	2/2/2	0.4	-	0.9999	0.6936	69.36
	sunflower	12.07.2018	40	20	1/1/1	0.2	1	-	-	-
	rape	12.07.2018	2680	2380	3/3/3	1.2	7.9	1.5849	0.3574	22.55
6	halophilous meadow	09.05.2016	4260	4160	6/6/6	3.4	41.6	2.5849	1.541	59.62
		13.07.2018	15740	15080	9/12/12	7.2	22.8	3.5849	1.6972	47.34
	barley	06.06.2017	1900	1300	7/8/9	4	2.17	3.1699	2.6881	84.8
	sunflower	13.07.2018	880	880	4/6/7	2	-	2.8073	2.1901	78.02
	lucerne	13.07.2018	320	320	7/7/8	2	-	2.9999	2.521	84.03
7	halophilous meadow	13.07.2018	4000	3880	7/7/7	4.4	32.3	2.8073	2.039	72.63
	wheat	07.06.2017	20	20	1/1/1	0.2	-	-	-	-
		13.07.2018	1220	1220	4/5/5	3.2	-	2.3219	1.5241	65.64
8	halophilous meadow	13.07.2018	4820	4700	4/4/5	3.4	39.17	2.3219	1.5898	68.47
	lucerne	07.06.2017	2440	1620	4/4/5	1.6	1.97	2.3219	1.3556	58.38
		13.07.2018	2800	2480	12/12/13	4.6	7.75	3.7004	2.2831	61.7
	sunflower	07.06.2017	3160	1740	6/6/7	3	1.22	2.8073	1.4347	51.11
	wheat	13.07.2018	2740	2640	7/8/9	2.4	26.4	3.1699	1.9692	62.12
9	pea	07.06.2017	300	280	5/5/5	1.2	14	2.3219	1.8064	77.8
10	xerophilous meadow	23.09.2015	4760	4240	6/8/8	3.8	8.2	2.9999	1.0122	33.74

Legend: Ā – global average abundance (individuals/m²); number of taxa: F-families, G-genera, S-species; S' - average number of species/sample; H(S)_{max} – maximum specific diversity; H(S) – real specific diversity; H.r. - relative diversity (%); *1-10 localities (see Table 1)

Regarding the species distribution, it can be observed that some species occur in the most of

the investigated sites, often with high ecological significance, as *Scheloribates labyrinthicus*, *S.*

pallidulus, *Epilohmannia cylindrica*, *Multiopia* (H.) *moritzi*, *Oribatula* (Z.) *connexa*, *Zetomimus* (P.) *acutirostris*. Other species have a high ecological significance only in certain habitats: *Exochocephus laticuspis*, *Bipassalozetes reticulatus*, *Hypozaetes bulgaricus*, *Birsteinia clavatus*, *Sphaerochthonius splendidus*.

Analysis of the global structural parameters of oribatid communities reveals large variations in global average abundance, especially depending on site conditions and less on the habitat type (table 2). However, the highest values were recorded in natural meadows, especially at Beștepe and Murighiol, although wide variations were observed depending on the sampling season.

The number of species generally varies in the same direction as the global abundance, but not proportionally (table 2). Thus, the highest species richness was observed in the xerophilous meadow at Beștepe, and also at Murighiol, while in the pastures at Sarinasuf and Popu the number of species was lower, even compared to some agroecosystems. Immature stages are generally underrepresented, so the adult / immature ratio is high, therefore large population fluctuations are expected in most investigated sites. Specific diversity has generally lower values in agroecosystems compared to meadows, but the real and relative diversity are relatively low in all investigated sites, indicating a reduced self-regulation capacity and a poor stability of the oribatid communities.

CONCLUSIONS

The faunistic investigation led to the identification of 60 species of oribatid mites, *Ctenacarus araneolus* (Grandjean, 1932), *Exochocephus laticuspis* (Balogh and Mahunka, 1965) and *Oribatula* (*Zygoribatula*) *andrianovae* (Bulanova-Zachvatkina, 1967) being recorded for the first time in Romanian fauna.

The global average abundance and number of species varies widely from one sampling site to another, even in the case of similar ecosystems. In the non-grazing meadows generally higher values of these parameters were observed compared to cultivated soils and pastures.

From a qualitative point of view, notable differences were observed in the species composition of the oribatid communities in meadows and crops, even if they were located in the immediate vicinity. On the other hand, a degree of similarity was noted in the species composition

and structure of oribatid coenoses in the agroecosystems.

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CURRENT SITUATION OF INSECTS SPECIES WHICH ARE AFFECTING THE PLANTS IN THE BOTANICAL PARK OF TIMISOARA

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Abstract

The green spaces represent places of relaxation and release from the daily stress for many of the inhabitants of Timisoara but also from the other villages of the Timis county. The botanical park or botanical garden is one of the most visited green places, being located near the central historical area and also constituting an important didactic and scientific support. The plants that enter its composition are both herbaceous and arboreous. In the last 10 years since its rearrangement, a number of plants have been affected by insects, either indigenous or invasive. A current overview of the analyzed landscape shows that it has lost its aesthetic and scientific qualities, so that areas with healthy plants alternate with areas with affected plants (natural color change, appearance of sticky secretions and inadequate odors due to the attack of Hemiptera, premature maturation, etc.). For an efficient management of the monitoring activities, the park was divided into 5 sectors, in which, 10 observation points were established. Monthly, during May-September, 2019, readings were made at each observation point (identified with the help of GPS mobile). From our observations it was found that the following species of insects were present, at a medium and high population level: *Metcalfa pruinosa*, *Nezara viridula*, *Cydalima perspectalis*, *Cameraria ohridella*, *Tetranychus urticae*, *Eriophyes tiliae*, *Trialeurodes vaporariorum*, *Aphis gossypii* and *Eriosoma lanigerum*. Also other species were observed, but at a lower level. We focused mainly on invasive species, which unfortunately were the most aggressive, in many cases their attack manifesting until the plant is compromised. This is the case of the species *Metcalfa pruinosa* (from Hemiptera) and *Cydalima perspectalis* (from Lepidoptera) which have proved to be the most dangerous insect species for the plants in the botanical park.

Key words: monitoring, insect pests, invasive, botanical garden

The Botanical Park in Timisoara, better known as the Botanical Garden, was established in 1986.

Its location in the central area of Timisoara makes it extremely attractive and frequented. It extends an area of over 8 ha and is divided into several sectors with floristic and vegetation specificity (Lajos K., 2015).

The main purpose, recreational, is added to the scientific one, mainly didactic.

In accordance with the information provided by the Environmental Directorate of Timisoara Municipality (<http://www.dmmt.ro>), the sectors are mainly focused on the native flora and vegetation (from Romania and especially from the Banat region), on the ornamental flora of roses; on the flora of America and Asia and to a lesser extent on the medicinal and tropical flora.

Initially, many more specimens of plants were present (about 1000), now there are just over 200 species. All these because in recent years deforestation and correction work have been carried out, removing plants debris or eliminating

the plants attacked by pathogens and pests (Ciupa V. *et al*, 2015).

The role that biotic factors (harmful insects and pathogens) play in endangering the health of existing plants in the park is extremely important and requires great attention in the future.

It is known that botanical gardens all over the world are facing problems to protect biodiversity, due to various biological threats that can create imbalances in the proper functioning of plants. These are the result caused by anthropic factor and the globalization of trade which creates conditions conducive to the occurrence of pests and diseases (Marek B. *et al*, 2016).

Although the management of invasive species in urban landscapes has been in the forefront in recent years, it remains a challenge today (Gaertner M. *et al*, 2016).

Of the newly emerged and lately present species in green spaces and parks in public places (from the western part of Romania), it is worth mentioning *Metcalfa pruinosa*, *Nezara viridula*,

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Cydalima perspectalis and *Leptoglossus occidentalis* (Grozea *et al.*, 2019).

In the present paper we set out to evaluate the current situation of the Botanic Park in Timisoara in terms of monitoring activities of harmful insects that cause damage, both of native and foreign species.

MATERIAL AND METHOD

The observations that are the subject of this paper are made in the municipal area of Timisoara (Timis County), more precisely in the botanical park known and as a botanical garden. The park was divided into 5 sectors (observation areas) (figure 1) identified with the following geographical coordinates: zone 1: Lat. 45.7592, long. 21.2254; zone 2: Lat. 45.7608, long. 21.2259; zone 3 Lat.

45.7613 long. 21.2267; zone 4 Lat. 45.7606, long. 21.2250 and zone 5: Lat. 45.7614 long. 21.2286.

In each area (sector) were established 10 observation points, maintained at each monthly reading (direct observations). The observation period was made between the vegetation months May-September 2019, on the principle that all the analyzed plants were attractive for most phytophagous insects (figure 2).

Table 1 presents the basic elements of each sector, such as type of analyzed plants (layers with flowers, herbaceous plant, woody plants and meadow) or condition of analyzed spaces (clean, without weeds or wild with weeds present).

Samples of insects but also of affected plants were taken and transported in order to identify accuracy at the university laboratory (Laboratory of Diagnosis and phytosanitary expertise).



Figure 1 The sectors (areas) in which the monitoring observations were made; 1-5 areas (satellite image taken from the public space where modifications have been made)

Table 1

Basic elements of research area (Botanical Park Timisoara)

No.	Zone/Sectors Identification code	Type of the plants analyzed	State of analyzed spaces
1	BPZ01 (S1)	layers with flowers meadow herbaceous plant woody plants	clean, without weeds
2	BPZ02 (S2)	herbaceous plant layers with flowers woody plants meadow	clean, without weeds
3	BPZ03 (S3)	herbaceous plant woody plants meadow	bushes with weeds present
4	BPZ04 (S4)	herbaceous plant woody plants meadow layers with flowers	bushes with weeds present
5	BPZ05 (S5)	herbaceous plant woody plants meadow	bushes with weeds present

BP- Botanical Park; ZO- zone; (S)- sector;



Figure 2 Moments of observations made in the Timisoara Botanical Park during May-September, 2019

RESULTS AND DISCUSSIONS

Following the observations made in the Timisoara Botanical Park, numerous insects belonging to 17 harmful species were quantified and examined. These belonged more to the group of hemiptera and lepidopterans, but also to beetles and mites (table 2).

Phytophagous insects were found in all 5 sectors subject to monitoring. Most, however, were registered in S5 which is the most isolated sector, where there are present areas of meadows, grasses but also woody plants. It should be added that in this area/sector bushes and weeds are more

common than in other sectors, perhaps because of this the insects have found an optimal environment for development. The lack of layers of flowers that are usually better maintained and cleaned of weeds can also be a cause.

Of the 17 species of insects, the best represented numerically were those of the genus *Trialeurodes* (code P7 in table 3) with an average of 98.60 ind., followed by *Aphis rosae* (P11) with the average values of 95.00 ind. after by those of *Corynthucha ciliata* (P17) with an average of 83.80 ind. then P1 (*Metcalfa pruinosa*), P9 (*Eriosoma lanigerum*) and P8 (*Aphis gossypii*) with the values $x = 82.20$ ind./P1, $x = 70.40$ ind./P9 if $x = 69.80$ ind./P8.

Table 2

Situation of population level of the species identified in Timisoara Botanical Park, during the period May-September, 2019

No crt (P)**	Species	Major insect group	Presence (+) /sectors (S)	Total number of individuals*				
				May	June	July	August	Sept.
1	<i>Metcalfa pruinosa</i>	Hemiptera	S1-S5 (+)	19	46	147	88	111
2	<i>Nezara viridula</i>	Hemiptera	S3-S5 (+)	23	41	58	24	67
3	<i>Cydalima perspectalis</i>	Lepidoptera	S2 (+)	25	38	12	7	45
4	<i>Cameraria ohridella</i>	Lepidoptera	S4-S5 (+)	12	46	31	58	11
5	<i>Tetranychus urticae</i>	Acarina	S2, S5 (+)	26	55	48	61	26
6	<i>Eriophyes tiliae</i>	Acarina	S3-S5 (+)	0	36	34	56	22
7	<i>Trialeurodes vaporariorum</i>	Hemiptera	S1-S5 (+)	41	100	231	121	0
8	<i>Aphis gossypii</i>	Hemiptera	S1-S5 (+)	10	74	190	43	32
9	<i>Eriosoma lanigerum</i>	Hemiptera	S4-S5 (+)	36	176	65	19	56
10	<i>Leptoglossus occidentalis</i>	Lepidoptera	S3-S5 (+)	6	0	0	0	3
11	<i>Aphis rosae</i>	Hemiptera	S1, S3 (+)	81	166	51	20	53
12	<i>Halymorpha halis</i>	Hemiptera	S3, S4 (+)	0	15	43	90	87
13	<i>Phylotreta sp</i>	Coleoptera	S1-S5 (+)	10	39	0	0	21
14	<i>Cossus cossus</i>	Lepidoptera	S5 (+)	0	0	1	3	0
15	<i>Cerambyx cerdo</i>	Coleoptera	S4-S5 (+)	3	8	0	0	0
16	<i>Lymantria dispar</i>	Lepidoptera	S5 (+)	5	0	3	3	0
17	<i>Corynthucha ciliata</i>	Hemiptera	S4 (+)	32	10	68	120	189

*only the active stages (larva, nymph or adults) were identified; (+)-the presence of species in the analyzed

Sector; (P)- code pest

Tabel 3

Statistical values of each insect species (identified with code P1-P17)

	P1	P2	P3	P4	P5	P6	P7	P8	P9
X	82.20	42.60	25.40	31.60	43.20	29.60	98.60	69.80	70.40
s	50.91	19.78	16.29	20.70	16.36	20.56	88.14	71.04	61.67
Sx	22.77	8.85	7.28	9.26	7.32	9.20	39.42	31.77	27.58
CV	61.93	46.43	64.13	65.49	37.87	69.47	89.39	101.78	87.60
Sx%	27.70	20.77	28.68	29.29	16.94	31.07	39.98	45.52	39.18

Continuation of table 3

	P10	P11	P12	P13	P14	P15	P16	P17
X	1.80	95.00	15.80	14.00	0.80	2.20	2.20	83.80
s	2.68	42.61	17.80	16.45	1.30	3.49	2.17	72.04
Sx	1.20	19.06	7.96	7.36	0.58	1.56	0.97	32.22
CV	149.07	44.85	112.63	117.48	162.98	158.77	98.54	85.96
Sx%	66.67	20.06	50.37	52.54	72.89	71.00	44.07	38.44

High values also were recorded for *Tetranychus urticae* species (with $x=43.20$ ind./P5), *Nezara viridula* (where $x=42.60$ ind./P2), at *Cameraria ohridella* (with $x=31.60$ ind./P4) and *Cydalima perspectalis* (where $x=25.40$ ind./P3) (table 2 and table 2a).

It deserves attention and the species *Eryophyes tiliae* (P6), *Halyomorpha halis* (P12) and *Phyllotreta sp* (P13) due to registered values ($x=29.60$ ind., $x=15.80$ ind. and respectively $x=14.00$ ind.).

A classification in the 4 levels of population assessment (low level-IV, medium level-III, high level-II and extremely high level-I) shows that in the category of insects (IV) that is not currently constitute a problem among the following species:

Lymantria dispar, *Cerambyx cerdo*, *Cossus cossus*, *Phyllotreta sp* and *Leptoglossus occidentalis* (figure 3). In the middle level category (III) the species include: *Halyomorpha halis*, *Eriophyes tiliae*, *Tetranychus urticae*, *Cameraria ohridella*, *Cydalima perspectalis* and *Nezara viridula*.

Species that are considered dangerous and fall into category II of high level are: *Eriosoma lanigerum*, *Aphis rosae* and *Aphis gossypii*.

Extremely dangerous by the very high level present on the plants (over 400 individuals being registered in the observation points) are *Metcalfa pruinosa*, *Trialeurodes vaporariorum* and *Corynthucha ciliate* (figure 3).

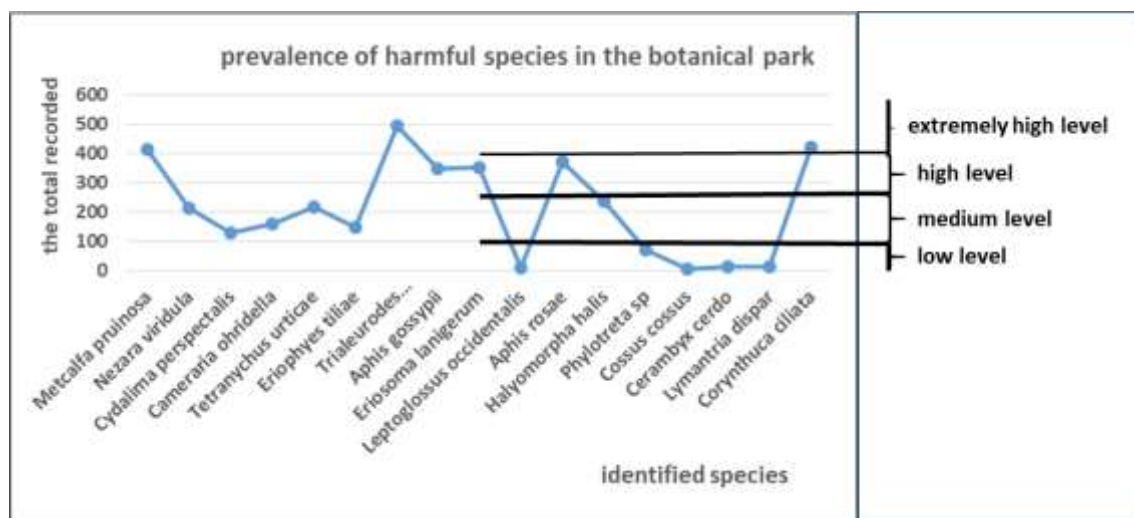


Figure 3 The predominance of the species in the observation points in the botanical park by the prism of the population registered in 2019

Regarding the monthly dynamics of the complete set of active insect pests, during the period May-September, it can be seen in figure 4 that it registered a sudden increase in the period May-June, then a slight increase in July. In July, the maximum value was registered (with 1403

individuals/S1-S5). In August, the presence of insects decreased considerably, then in the first days of September their frequency increased. After September 15, with the fall of the temperatures, their presence diminished.

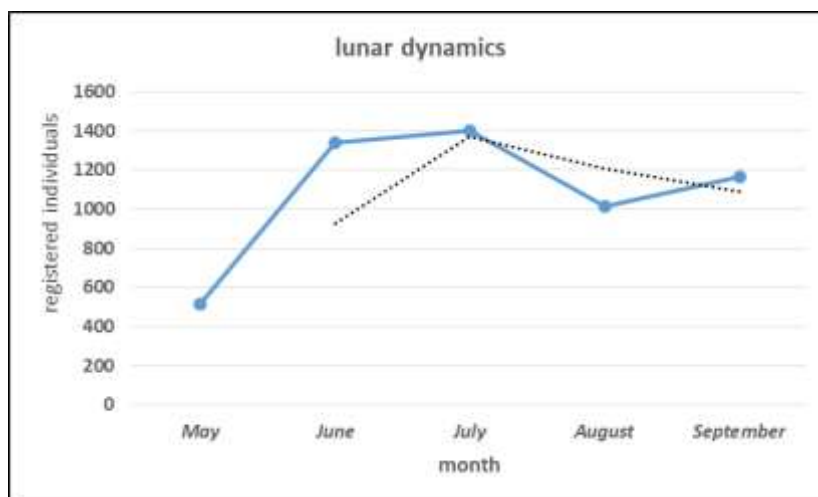


Figure 4 Monthly dynamics of the species of insects observed/ present in the botanical park, during the period May-September

Out of the total species of active insects present in the 5 sectors of the Timisoara Botanical Park, 5 invasive species have been identified that have recently entered Romania. These are *Metcalfa pruinosa*, *Nezara viridula*,

Leptoglossus occidentalis, *Cydalima perspectalis* and *Corynthucha ciliata* (figure 5). These are represented by a considerable number of individuals, so that the percentage reaches 18.34% of the total registered insects.



Figure 5 Invasive insect species identified during monitoring, in the Timisoara Botanical Park during May-September, 2019; a- *Metcalfa pruinosa*, b- *Nezara viridula*, c- *Leptoglossus occidentalis*, d- *Cydalima perspectalis*

CONCLUSION

The presence of invasive species in the Timisoara Botanical Park is a danger to the set of plants that make up the living plant collection. It is known that these species have no natural enemies and there is no strategy to combat them.

Also, the increase of the population level in some native species, at an extremely high level, supplements the stress on the plants.

Therefore, control strategies are required in the future to ensure permanent protection of plants during the vegetation period.

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RESEARCHES ON THE IMPLEMENTATION OF THE FOREST CADASTRE USING THE GNSS TECHNOLOGY AND THE REMOTE SENSING

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Abstract

In Romania, about 27% of the land area is the forest fund. Sustainable development of forest involves their inventory and permanent updating in order to achieve a precise cadastral record. The land that are part of the forest cadastre are mainly represented by wooded land. The work consists in identifying and delimiting the cadastral area of a forest plot using modern ways of locating and tracking changes in time. The research aims to determine the modern aspects regarding cadastre and forest management issues, as well as how to create a database of the type of Geographic Information Systems, necessary in the context of the development of forest resources. In order to achieve the proposed objective, modern technologies for field measurements were used, such as high-precision Trimble GNSS systems, capable of providing a high degree of precision and productivity. Thanks to the built-in technology, GPS receivers, receive signals from all existing satellite constellations, ensuring a high quality of the measurements made. The studied area was also analyzed using satellite imagery which allowed the delimitation of forest boundaries through the digitization process. The use of very high resolution satellite imagery ensures high digitization accuracy, taking place in a shorter time than the terrestrial measurement method. Inventory of forests also involves the registration of plots in the Land Book. Through the ETERRA 3 application, the areas entered in the integrated national cadastre and land register can be viewed, interrogated and updated at all times. Since clearance is a major current problem, the most accurate and efficient cadastral survey and record keeping of forest enables sustainable forestry development in order to ensure a good quality of life.

Key words: forest cadastre, Eterra 3, GNSS, GIS, remote sensing.

The forest cadastre aims to efficiently manage forests, by delimiting the edges of the lands belonging to the forest fund, for their proper functioning, from the ecological, economic and social point of view. The delimitation of forest plots is part of an extensive forest inventory process, which takes place whenever changes of the managed areas occur.

Performing field measurements using GNSS technology provides conclusive results on determining the various details. For a higher accuracy of the calculated points, the distance between the GPS receivers installed at the edge of the forest must be taken into account (Crainic G. C., 2009).

The identification and delimitation of forest land is a major challenge in the administration and management of forests. The forest information system refers to the process of generating geospatial data, exchange of spatial information about forest areas, associated resources and activity management, for their sustainable management. The development of new satellite technologies allows terrestrial observations to be

made with spatial resolution of 0.60m or even 0.41m, having high speed computing and processing capabilities. High resolution satellite imagery shows its usefulness in topographic measurements, thanks to which the cadastral system and land inventory systems have undergone major changes worldwide (Mothi Kumar K. E. *et al*, 2014).

Realization of the Geographic Information System and a database corresponding to the forestry fund owned by the different administrative-territorial unit, it is necessary, in the context of sustainable management of forest resources. To achieve the quality of the final product on the information provided, it is necessary to collect and process primary data with adequate accuracy (Marincaș I. B. *et al*, 2009).

Monitoring of the forest fund, by performing topographic measurements, it is of particular importance in the context of identifying clearance forest plots, tracking the afforestation works, etc.

Disorganized forest exploitation leads to the occurrence of flood propagation phenomena and the transport of wood waste (M. Luca, L. A. Luca,

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2014).

The purpose of this paper is to determine which is the most accurate and reliable method of

MATERIAL AND METHOD

The research material consists of a forest area located on the left bank of the Bahlui river,

finding the surface of a forest plot, in the context of efficient and permanent monitoring of the national forestry fund.

In the commune of Deleni, Iași county, near the Pârcovaci dam (*figure 1*).

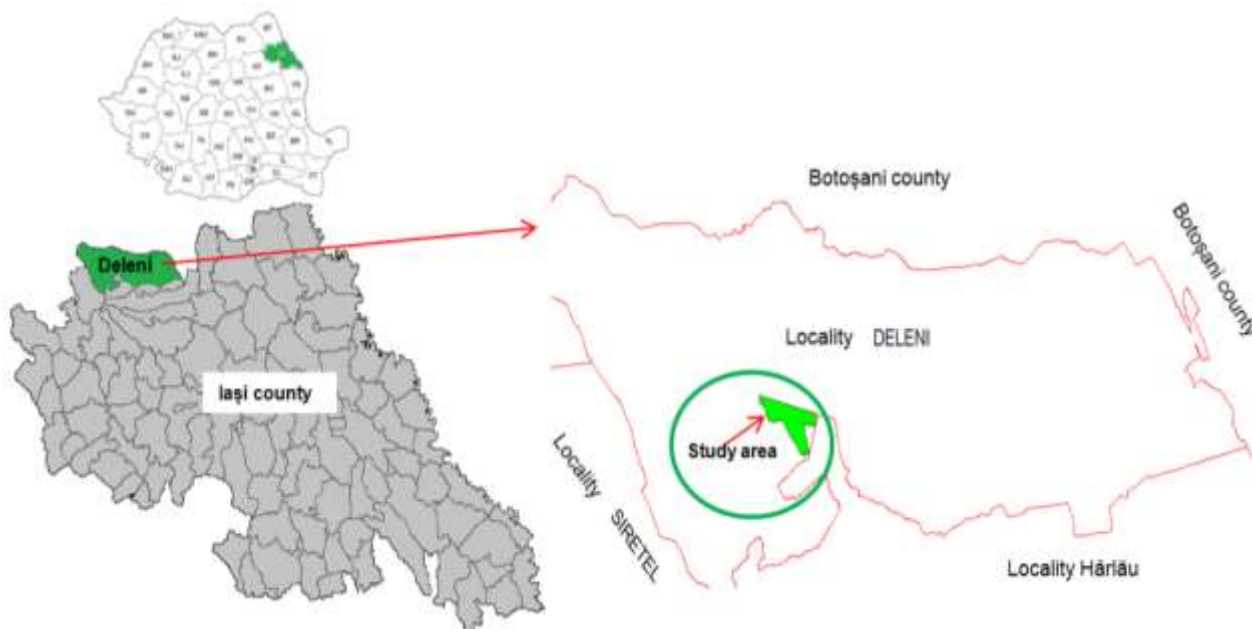


Figure 1 Representation of the North-East region of Romania with the location of the studied forest area

Introduction of the unitary system of cadastre and land book, regarding the articles of Law 7/1996, applies to all cadastral sectors and buildings in the country (V. Moca et al, 2018). Thus, the forest areas are located technically and legally and economically inventoried.

The research methodology consists of:

- Performing topographic field measurements using GNSS positioning technology. For this purpose, two high-performance receivers were used, the Trimble R2 GPS and the Trimble R8 GPS, which determined the coordinates of the points that describe the geometry of the studied area.
- Downloading data in the Autocad work environment.
- Joining the measured points and determining the outline of the study area.
- Comparison of the limits measured with the limits of the existing plot in the Eterra 3 program and taking over sectors of the boundary.
- Cartographic analysis of the studied plot by framing it on geodesic trapezoids.

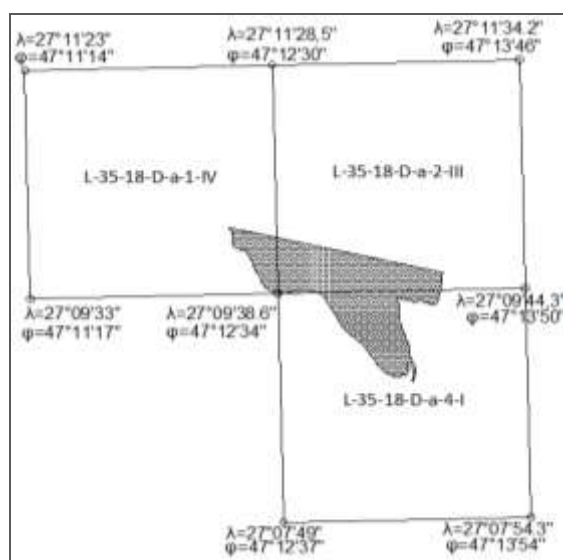
- Analysis of the plan of location and delimitation of study area by comparison with the cadastral map drawn up in 1989.

- Analysis and interpretation of satellite images taken in July, between 2016-2019.

RESULTS AND DISCUSSIONS

The forests included in the national forest fund cover a minimum area of 0.25 ha and they are covered with trees that, at maturity, reach a height of at least 5m. The studied area is located on the left bank of the Bahlui river near the Pârcovaci dam, being represented by a leafy forest area of approximately 120 ha.

For a more precise geographical location of the objective, the classification was made on geodesic trapezoids, with nomenclatures on the scale 1:5000. At the same time, the geographical coordinates of the corners of the geodesic trapezes were established (*figure 2*).



a.



b.

Figure 2 The geographical location of the study area: a. Fitting on geodesic trapezoids; b. PUG limit and the studied area

The geographical coordinates ϕ , λ of the trapezoid corners were calculated by converting the stereographic coordinates X , Y (Agapie I., Luca M., 2019).

The topographic measurements in the field were executed on a length of 1686.314m, on the forest road that delimits the studied area. The stereographic coordinates for 43 points were determined (table 1). The measurements were

performed using the GNSS positioning method (figure 3), with Trimble R2 GPS receiver, having an accuracy of 10 mm +1 ppm in horizontal determinations. The second receiver used, the Trimble R8 GPS, determined the points with an accuracy of 8 mm + 1 pp, in horizontal measurements.



a.



b.

Figure 3 Presentation of high precision GNSS technology: a. View Trimble R2 and Trimble R8 models; b. Making planimetric measurements;

Table 1 presents some of the determinations made in the field. The measured points are represented in the attached sketch (figure 4) and are compared with the determinations from the database of the National Agency for Cadastre and Real Estate Advertising. The differences between

the measured points and those extracted from the ANCPPI database are in the order of centimeters, falling within the acceptable tolerances. The existing differences are due to the fact that the points in the ANCPPI database are not materialized in the field.

Table 1

The coordinates of the points measured in the field

No. Point	X [m]	Y [m]	No. Point	X [m]	Y [m]
1	663137.951	637899.719	10	662796.791	637948.170
2	663114.452	637906.119	11	662772.875	637941.380
3	663043.975	637906.489	12	662784.252	637919.124
4	662996.615	637920.204
5	662947.543	637949.658			
6	662904.821	637963.980			
7	662882.553	637967.163	41	663331.844	637262.565
8	662866.303	637967.337	42	663355.664	637247.651
9	662843.462	637961.758	43	663400.159	637227.272

In the past, all the forest lands were under state administration (Romsilva). Due to the laws for the retrocession of agricultural and forest land, forests became 50% public state property and 50% private property (natural or legal persons). The forests belonging to the administrative-territorial units are in the form of public property: they

belong to the public domain of the locality, the municipality or the county (L. Bouriaud, 2013).

The forest plot of the case study had a total area of 1199176 mp. Following the retrocession process, its surface became 1108741 mp. So the forest lands receded totaling 90435 mp and are highlighted in *figure 4*.

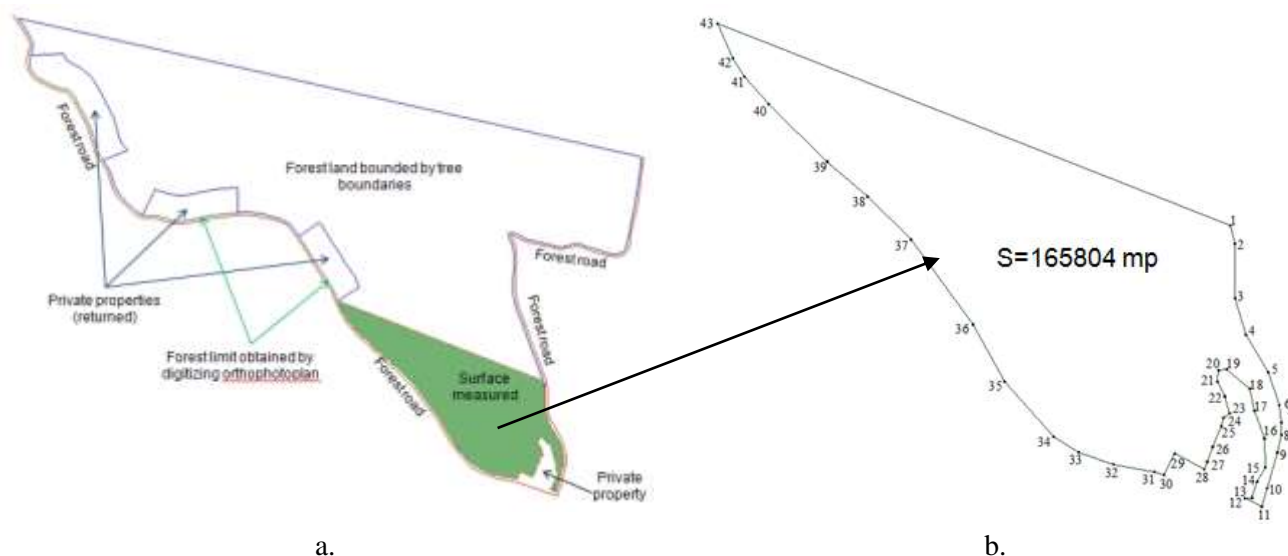


Figure 4 Identification of forest boundaries: a. Indication of forest boundaries before and after retrocession; b. Representation of the points on the contour of the measured area;

The measured surface area as well as the surface taken from the Eterra 3 database and the one obtained by digitization, they can be analyzed in relation to the cadastral map made in 1989 (*figure 5*). You can see small differences between the forest limit in 1989 and the one currently obtained by digitizing the orthophotoplan. This is mainly due to the old methods, used in the past,

with a low accuracy of measuring the contour elements of the forest spaces.

Orthophotoplanes are products of modern technology, made with the latest aerial equipment, by specialized companies who have the resources to obtain such parts. Orthophotoplan is one of the main pieces in the realization of the basic cadastral plan, for the correct and accurate inventory of the entire land fund of the country (M.D. Prața, 2012).

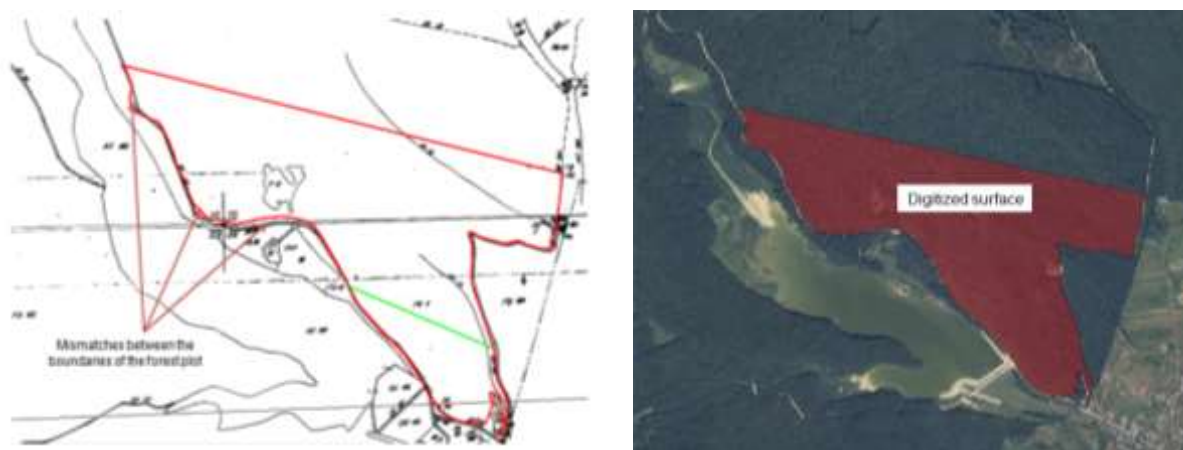


Figure 5 **Identification of forest boundaries: a. Forest limits on the cadastral plan draw up in 1989; b. Forest limits obtained by the digitization process on the orthophotoplan taken over in 2016;**

Performing measurements in the field and processing the orthophotoplanes helps to establish the topographic limits of the studied area. A more detailed method of monitoring the studied forest area is the analysis of satellite images.

Satellite platforms provide high spatial coverage, without access limitation. The data sets provided by the satellite systems, for the surfaces covered with vegetation, can be used for the purpose of obtaining different data (A.T.Nerțan și V.Panaiteșcu, 2016).

For the studied area was calculated Normalized Difference Vegetation Index (NDVI), in order to establish the density of vegetation. The

satellite images taken by the Landsat 7 satellite in July between 2016-2019 have been downloaded from the website <http://earthexplorer.usgs.gov/>.

NDVI index (Normalized Difference Vegetation Index) compares vegetation density between satellite images, using near-infrared and visible red waves (G. Costea, 2012).

The formula for calculating the NDVI index is: $NDVI = (NIR - R) / (NIR + R)$, where NIR is the near infrared band and R is the red band.

The NDVI index analysis was performed in ArcMap 10.2, the results obtained being analyzed by years, starting with 2016 and until 2019 (figure 6; figure 7).

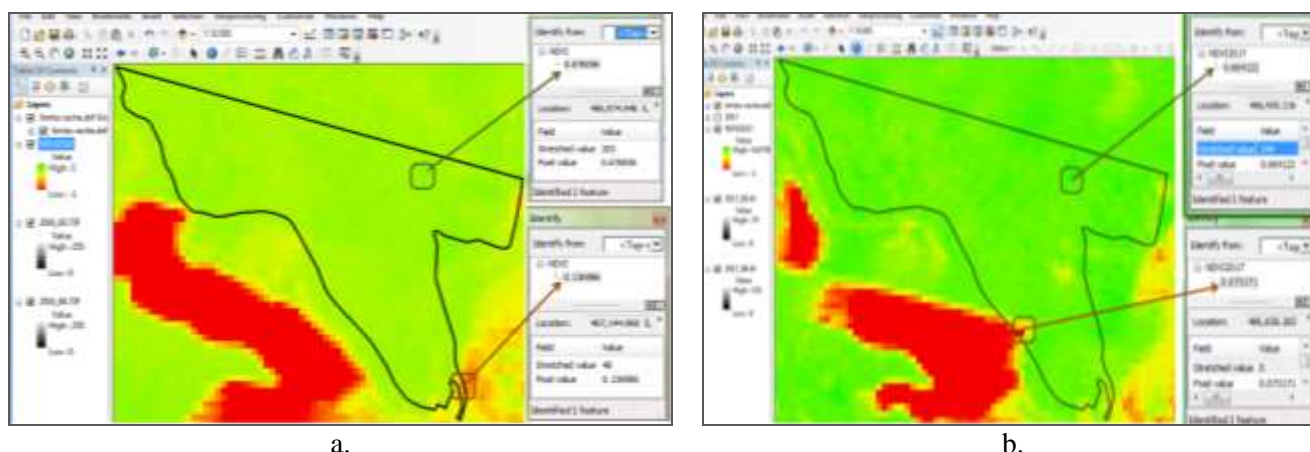


Figure 6 **Identification of maximum and minimum values of vegetation density for the studied area: a. July 2016 b. July 2017**

For satellite images taken with the Landsat 7 satellite, the near infrared is band 4 and the red band is band 3. The NDVI index values are in the range -1 to 1. For a normal vegetation the values are between 0.1 and 0.75, rarely reaching the value 1 (I. Vorovencii, 2015).

The maximum and minimum values of the NDVI index, for July 2017, are lower than those

recorded in July 2016. However, we can see an increase in the density of vegetation in 2017, compared to 2016, the average of the NDVI index registering values over 0.5 in almost the entire studied area.

In 2018, there is a marked degradation of vegetation, the minimum NDVI index reaching -0.124, well below the minimum value for normal

vegetation. In 2019, the maximum value of the vegetation density is 0.1, and the minimum value –

0.05 (figure 7).

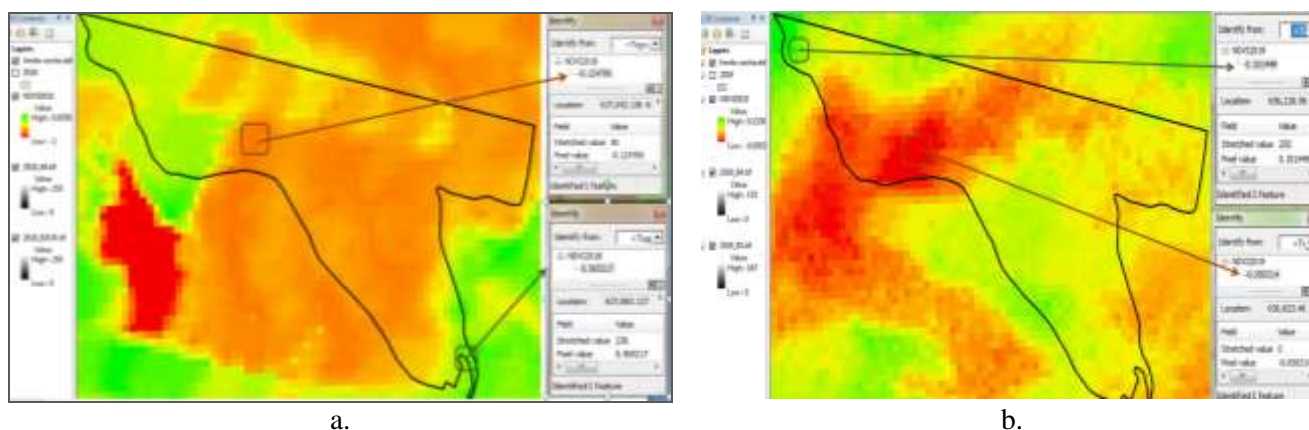


Figure 7 Identification of maximum and minimum values of vegetation density for the studied area: a. July 2018
b. July 2019

CONCLUSIONS

The study indicates the importance of topographic and satellite information in the development of a GIS database to enable the management, updating and interpretation of information on the observed forest area.

Making fields measurements with high-performance GNSS technology, accurately determines the order of the centimeters, the location of the studied forest area.

The retrieval of topo-cadastral information from old cadastral maps, orthophotoplanes but also from the ANCP database, indicates the evolution over time of the forest plot limit.

Remote sensing is the most modern and reliable way of analyzing the density of vegetation, to determine, in time, the evolution of the forest.

A future direction of study may be the realization of a complex GIS database, for the inventory and analysis of all forest areas in Romania, for making the right decisions regarding the process of deforestation and degradation of vegetation.

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SOFTWARE APPLICATIONS FOR THE USE OF AERIAL IMAGES IN PRECISION AGRICULTURE

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Abstract

Precision agriculture represents a new branch developed due to the new technologies, which represents, for most farmers, a challenge in their use in order to obtain improved productions from year to year, and the conservation of the potential of agricultural lands.

Determining the problems of agricultural crops, was done recently through field inspections, which requires a great deal of time.

The emergence of drones, dedicated applications for using the results obtained with the help of drones and other new technologies, such as multi-spectral satellite imagery, opens a new perspective for farmers, which allows them to obtain better results in the field of crops but also the conservation of agricultural land.

The use of drones and the applications dedicated to the processing of the data obtained with them, will allow to increase the efficiency of the farms and also to conserve the potential of agricultural lands. It will be possible to determine precisely the areas in which to intervene in case of drought / excess humidity, deficiency / excess of nutrients. Also, yield maps can be made that will highlight the distribution and density of the plants on the surface, the number of berries / fruits, etc. Early detection of weeds, fungi and other pests in crops, to prevent their spread as well as various diseases.

At present, more and more farmers are convinced of the efficiency of drone application and precision agriculture applications. In addition to these solutions, farmers also need machines dedicated to the application of the results obtained with these technologies (agricultural equipment equipped with GPS, sensors for various climatic and soil parameters, variable nozzles for seeders and fertilizers, motion / rotation sensors, counters, etc.).

Key words: precision agriculture, drone, aerial imagery

Precision agriculture represents a new branch developed due to the new technologies, which represents, for most farmers, a challenge in their use in order to obtain improved productions from year to year, and the conservation of the potential of agricultural lands.

The use of drones and the applications dedicated to the processing of the data obtained with them, will allow to increase the efficiency of the farms and also to conserve the potential of agricultural lands. It will be possible to determine precisely the areas in which to intervene in case of drought / excess humidity, deficiency / excess of nutrients. Also, yield maps can be made that will highlight the distribution and density of the plants on the surface, the number of berries / fruits, etc. Early detection of weeds, fungi and other pests in crops, to prevent their spread as well as various diseases.

MATERIAL AND METHOD

The emergence of drones, dedicated applications for using the results obtained with the help of drones and other new technologies, such as multi-spectral satellite imagery, opens up a new perspective for farmers, which allows them to achieve better results in the field of crops but also the conservation of agricultural land.

Determining the problems of agricultural crops, was done, until recently, through field inspections, which requires a great deal of time.

Precision agriculture is a new branch developed due to the new technologies, which represents for most farmers a challenge in their use in order to obtain improved productions from year to year, and the conservation of agricultural land potential (<https://www.geo-farms.com/precision-farming>).

The use of drones in agriculture involves a certain workflow, explained in the image below.

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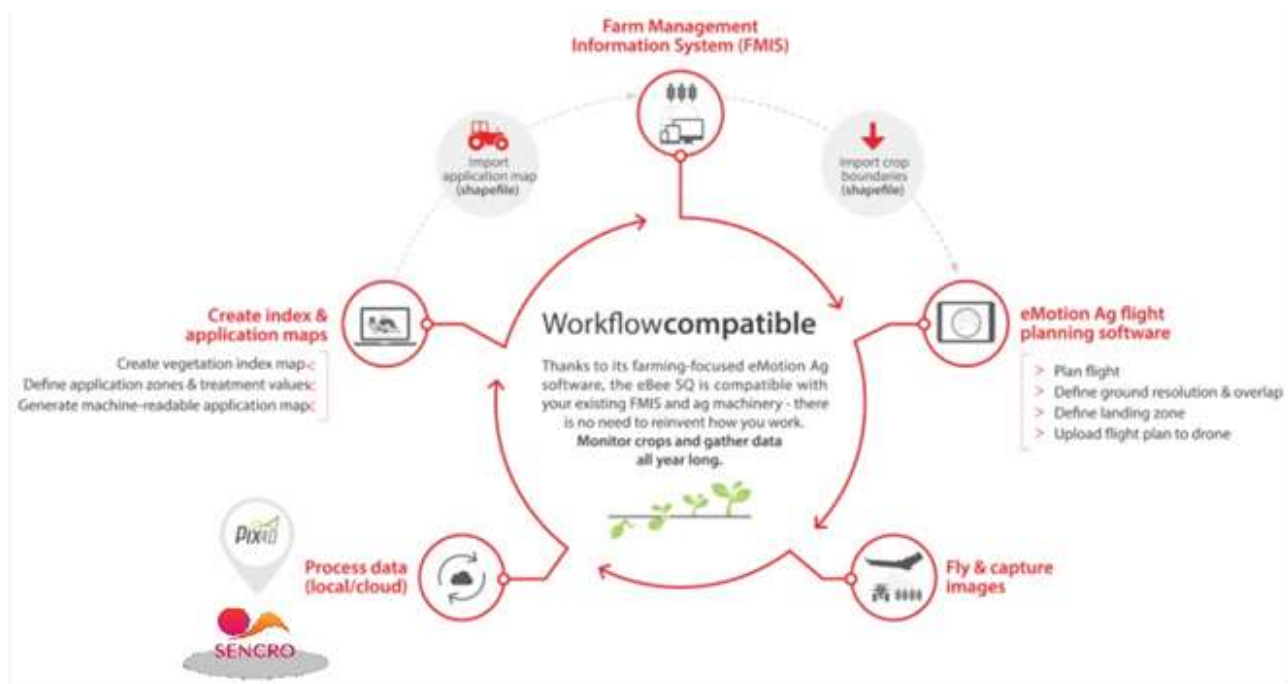


Figure 1 Workflow for the use of drones in agriculture

What data does a drone collect?

A drone allows the collection of aerial images on the ground, in RGB and multipsectral mode.

The processing of these images, by means of a special software, allows to obtain various information necessary for an agronomist engineer in order to establish the health status of the crops and the treatments that are necessary to improve their condition.

The software solution for the processing of photographic data, allows to obtain the following results:

- orthophotoplan of the studied area
- digital model of land for the studied areas
- multispectral image for the studied area

The combination of these results is done through dedicated software solutions. In this regard, SysCAD Solutions s.r.l together with the Faculty of Functional Improvements and the Environmental Engineering, participates together in the development of a software solution necessary for the information management of the farms. The development of this solution is coordinated by Mr. Engineer Dipl. Sasu Andrei Sebastian, employee of SysCAD Solutions s.r.l.

The application has the following functionalities:

- Real estate management

- Graphic connection to ANCPI cadastral numbers
- Contract management
- Property
- Lease
- Crop management
- Graphic view of buildings (map)
- Thematic maps on property or lease type buildings
- Satellite analysis NDVI, NDWI, temperature
- General report
- Topographic Information (ANCPI Cadastral Numbers, Tarla outline, plot plans)
- Geolocation - can be used from the mobile phone in the field

The application allows the analysis of data from multiple sources, such as:

- images obtained with the drone
- satellite images
- topographic maps
- maps for APIA
- multispectral images

This information is analyzed and the results obtained are displayed in various forms or reports, such as summary statistical reports for NDVI, NDWI, temperature, cumulative temperature for active physical blocks, etc (<https://www.sciencedirect.com/science/article/abs/pii/S0034425796000673>).



Figure 2 Reports for NDVI, NDWI, temperature, cumulative temperature for active physical blocks

The Crops menu allows the following operations:

- Shapefile file introduction (according to APIA requirements - Stereo 70 coordinates)
- Possibility of duplicating a crop to enter a new agricultural year
- Graphic representation of cultures
- Date of sowing and harvesting (estimated)

• Type of culture and physical block (information related to APIA)

• The name of the cultivated product

• Estimated production / ha (production culture capacity)

• Production done / ha

• Name / type and quantity of fertilizer at ha level

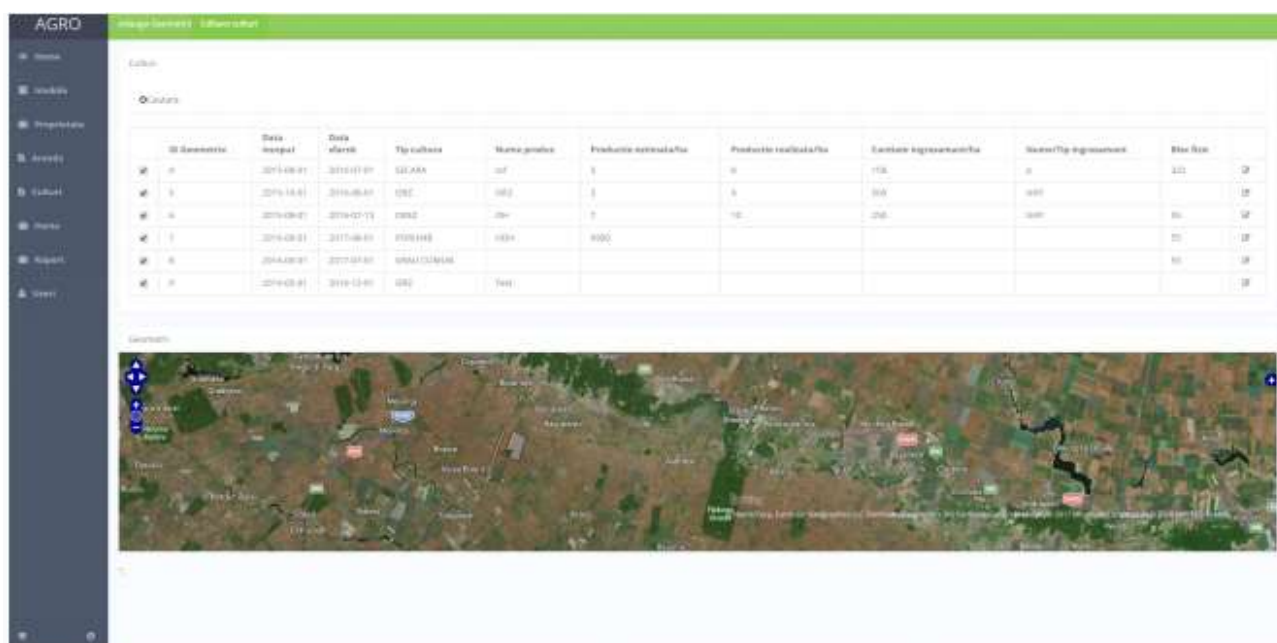


Figure 3 The Crops menu

Reporting the obtained results allows (<https://eos.com/ndwi/>; https://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf):

- determining the NDVI index
- determining the NDWI index
- drawing up a general report

RESULTS AND DISCUSSIONS

Why SENCRO?

SENCRO is a Romanian application, developed 100% for the needs of farmers in Romania, with the possibility of rapid adaptation to

their requirements, according to the demands of farmers, with a rapid response to the changes due to the legislation (https://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf).

As strengths of smart agriculture using drones and SENCRO, we can highlight the following:

• NDVI analysis helps to determine the level of fertilizer applied in the field (can lead to savings)

• NDWI analysis helps determine the level of water used in the land



Figure 6 Determination of the NDVI index



Figure 7 Determination of the NDWI index - the water level in the plant

CONCLUSIONS

The use of drones and the applications dedicated to the processing of the data obtained with them, will allow to increase the efficiency of the farms and also to conserve the potential of agricultural lands.

At present, more and more farmers are convinced of the efficiency of drone application and applications dedicated to smart agriculture.

In addition to these solutions, farmers also need machines dedicated to applying the results obtained with these technologies, such as:

- ☐ tractors equipped with GPS equipment
- ☐ seed nozzles with variable nozzle
- ☐ fertilizers with variable nozzle
- ☐ etc.

ACKNOWLEDGMENTS

We are grateful for the direct help received from the team of SysCAD Solutions S.R.L., who executed the drone flight and took over the aerial images necessary to realize the SENCRO application.

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- <https://eos.com/ndwi/>
- <https://www.sentinel-hub.com/eopproducts/ndwi-normalized-difference-water-index>
- https://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf

ASSESSMENT OF THE QUALITY OF SECONDARY PRODUCTION FROM DIFFERENT AGRICULTURAL CROPS USED AS PRIMARY MATERIAL FOR DENSIFIED SOLID BIOFUELS

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Abstract

The quality of densified solid biofuels is directly influenced by the biomass characteristics used as feedstock. Under the conditions of the Republic of Moldova, the main source of raw material used in the production of briquettes and pellets is represented by agricultural residues and those from the food industry. For this reason, it is important to know the qualitative characteristics of these residues. The purpose of this study is to highlight the main qualitative parameters of agricultural residues used as energy sources specific for the Republic of Moldova. The issue of research refers to the estimation of the possibilities of using indigenous agricultural residues as a raw material for the production of densified solid biofuels with ENPlus 3 characteristics. The investigative methodology is based on a complex study, organized and realized in the Solid Biofuels Laboratory of the State Agrarian University of Moldova.

The paper presents the results of the research regarding the estimation of the calorific value, the moisture content, the ash content and the chemical analysis of the main agricultural residues from the agrarian sector depending on their origin and specificity, emphasizing on herbaceous, arboreal and vines residues.

The study showed that only about 10% of the residues from agricultural activities can be used directly to produce bio briquettes and pellets with qualitative indicators according to the requirements of ENPlus 3. It should be noted that practically, all agricultural and vineyard residues can be used as a raw material to the production of ENPlus certified densified solid biofuels, and herbaceous residues can only be used in mixtures with other types of vegetable biomass or require pre-treatment before densification, for example, by torrefaction.

Key words: agricultural residues, solid biofuels, calorific value, moisture content

The compliance with the requirements of the international standards EN Plus3 is one of the main factors which is directly affecting the economic and social aspects regarding the production of densified solid biofuels (DSBF).

For the beneficiaries the most important characteristics of biofuels are the calorific value and the ash and moisture content. When referring to the environment connected requirements the nitrogen, sulphur and chlorine content are the most severely regulated, as they favour the formation of acid rain and smog, have corrosive effects over metals and have a negative influence on the reliability of technological equipment (Marian Gr., 2016).

The above mentioned characteristics of the finite product depend on the properties of the raw material, which vary significantly according to its origin and source of origin. Vegetable biomass is the main component of raw material used for producing DSBF; the use of biomass is conditioned by a series of factors of which the

quantity and quality potential in the biofuel production location is the most important one.

The Republic of Moldavia has a large agricultural potential; as a result, the main source for producing DSBF is represented by the secondary products obtained when from the growing of different crops. The agricultural secondary products are: straws from cereal crops, stems from maize and sunflower crops, tendrils from dormant pruning of vines, branches from orchard pruning etc. (Marian Gr., 2016).

The use of agricultural secondary products as raw materials for producing DSBF is a common practice in several countries, including Moldavia and Romania. Moreover, in the last decade, data referring to the quality of agricultural biomass used for the production of DSBF is available in both international papers (Alakangas E.A., 2016; Bentsen N. S. *et al*, 2014; Algieri A. *et al*, 2019) and national literature (Hăbășescu I., Cerempei V., 2012; Marian Gr., 2016; Gudîma A., 2017; Pavlenco A., 2018).

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Based on the analysis of the specific papers we were able to establish that the results of the studies (especially the ones regarding the energy potential) vary significantly and are referring to specific types of biomass, according the climate areas taken into account.

The aim of the present study is the emphasize the most important quality parameters of the agricultural residues which are specific for the Republic of Moldavia, in order to evaluate the possibilities of using them for producing DSBF with the characteristics required by the international ENPlus 3 standards.

MATERIAL AND METHOD

The research was performed in the Laboratory for Solid Biofuels of the State Agricultural University of Moldavia. The main physical, chemical and energetic properties of different types of agricultural residues (herbaceous, but also from orchards and vineyards) were evaluated.

The calorific value was measured with the LAGET MS – 10A calorimetric bomb and the results were related to the content of dry substance. The high calorific value was measured and then the low calorific value at constant pressure was calculated using the specifications given by the SM EN ISO 18125:2017. The low calorific value was calculated based on the hydrogen, oxygen and nitrogen content, for the dry substance and for the moisture content of 10%.

The calorific value of the biomass with 10% moisture is important because this value of the humidity is recommended for the calculation of the available energy potential of biomass; it also represents the average humidity of biomass during processing. In the meantime, most of the agricultural secondary products are dried in the field down to a humidity of approx. 10%.

The moisture content was evaluated (dry basis) through weighting, according to the SM EN ISO 18134 1-3: 2017 standards series, which indicate the complete extraction of moisture form the tested material.

The ash content (dry basis) was evaluated according to the SM EN 18122:2017 standard, through slow calcination of the samples in the electric oven (LAC type LH 05/13) at 550 °C., for at least 6 hours.

The preparation of the samples was made according to the SM EN 14780:2017 standard. The biomass was grinded with the SM 100 mill and sieved with a 1 mm sieve. The chemical analysis was performed using the VarioMACRO cube CHNS&Cl elemental analyser. The detection and quantity analysis were performed using a thermal conductivity detector (TCD). The results were analysed using the dedicated software EAS, which enables the display, monitoring, recording and

processing of data in order to obtain the characteristics of the chemical elements.

RESULTS AND DISCUSSION

The energy potential of biomass is given by the calorific value. The calorific value depends on the chemical composition and moisture and ash content. The results of the analytical phase are presented in Table 2 as the average value of five measurements; the standard error and confidence interval are also presented.

The chemical analysis of the samples provides important information regarding the carbon, hydrogen and oxygen content, which have a significant influence over the calorific value of the finite product. The nitrogen and sulphur content are also presented as they have negative effects over the quality of DSBF; *table 1* presents the requirements of the Unplugs standard referring to the nitrogen and sulphur content.

Table 1
Requirements of ENPlus 3 regarding the nitrogen and sulphur content

Chemical element	Quality class		
	A1	A2	A3
Nitrogen	≤ 0,3	≤ 0,5	≤ 1
Sulphur	≤ 0,04	≤ 0,05	≤ 0,05

Considering the data shown in *table 1* and *table 2* it was concluded that, taking into account the nitrogen and sulphur content, only the maize cobs perfectly comply with the requirements of ENPlus standards. The other herbaceous raw materials may be only used in mixtures containing other types of wooden biomass (orchard branches and vine tendrils), thus reaching the imposed nitrogen and sulphur content.

Ash is a ballast in DSBF and is regulated by Unplugs standards as follows:

Pellets – 0.7% for class A1; 1.2% for class A2 and 2% for class En-B.

Briquettes - 1% for class A1; 1.5% for class A2 and 3% for class B.

Taking these values into account and comparing them with the results presented in Table 2 it was concluded that highest amount of ash (11.8% ash) results from the combustion of sunflower stems and leaves, followed by wheat straws (5.7%) and maize stems (4.6% ash).

For the rest of the herbaceous raw materials the ash content after combustion was lower than 3%, thus corresponding to the requirements of class B for briquettes. As an exception, with less than 2% ash, cobs may be used for producing class En-B pellets.

Table 2

Physical and chemical properties of agricultural residues

Crop	Biomass type	Moisture content, %			Ash content, %				Calorific value, MJ/kg			Chemical analysis				
		M _{r.av.}	σ	CI	A _{d.av.}	A _{av. M=10%}	σ	CI	q _{v.gr.d}	q _{p.net.d}	q _{p.net.m=10%}	C	H	N	S	O
Herbaceous agricultural residues																
Autumn and spring wheat	straws	17.7	3.2	2.8	5.7	6.4	0.8	0.1	18.4	17.1	15.2	45.6	5.80	0.48	0.08	43,3
Autumn and spring rice	straws	24.3	5.9	5.2	2.4	2.7	0.1	9.2	18.5	17.2	15.3	47.1	5.70	0.46	0.09	44,3
Oat	straws	19.5	3.3	2.9	2.7	3.0	0.1	0.2	18.1	16.8	14.91	46.1	5.80	0.47	0.08	44,9
Maize	stems	37.8	6.4	5.6	4.6	5.2	0.2	0.2	17.9	16.7	14.8	47.5	5.50	0.62	0.09	41,7
	cobs	45.9	6.4	5.6	1.8	2.0	0.1	0.1	19.1	17.8	15.8	45.9	6.01	0.46	0.03	45,8
Sunflower	stems and leaves	45.0	10.5	9.2	11.8	13.1	0.2	0.2	16.9	15.8	14.0	42.5	5.10	1.11	0.11	39,8
Average		31,7			4.8	5.4			18.2	16.9	15.0	45.8	5.7	0.6	0.08	43.3
Orchard agricultural residues																
Apple trees	Pruning	25.4	2.8	2.5	1.0	1.2	0.2	0.3	20.3	19.0	16.8	46.5	5.98	0.28	0.03	46.1
Pear trees		40.5	3.1	2.7	1.7	1.9	0.3	0.4	20.7	19.6	17.4	45.4	5.37	0.28	0.03	47.2
Quince trees		26.0	2.3	2.0	1.7	1.9	0.0	0.0	20.1	18.8	16.7	46.4	6.10	0.25	0.02	45.5
Cherry trees		25.5	2.6	2.3	1.0	1.2	0.2	0.2	20.7	19.4	17.2	47.7	6.03	0.28	0.04	44.9
Sweet cherry trees		27.6	2.3	2.0	1.6	1.8	0.3	0.3	22.1	20.8	18.5	44.9	5.66	0.32	0.03	47.5
Apricot trees		24.3	1.4	1.3	0.9	1.0	0.1	0.1	20.8	19.5	17.3	45.7	6.02	0.29	0.03	47.1
Peach trees		25.4	1.5	1.3	1.4	1.5	0.2	0.3	21.4	20.0	17.8	44.3	6.11	0.28	0.03	47.9
Plum trees		34.8	1.9	1.7	0.8	0.8	0.5	0.6	21.4	20.1	17.8	45.2	6.08	0.30	0.03	47.6
Average		28,7			1.3	1.4			20.9	19.6	17.4	45.8	5.9	0.3	0.03	46.7
Vineyard agricultural residues, table grape varieties																
Moldova	pruning	36.3	2.0	1.8	2.5				20.7	19.4	17.2	46.4	5.96	0.34	0.03	44.8
Cardinal		37.3	1.7	1.5	2.4				20.3	19.1	16.9	46.4	5.83	0.44	0.03	44.9
Muscat of Hamburg		36.6	2.6	2.3	2.5				20.2	18.9	16.8	46.4	5.98	0.35	0.03	44.8
Early Muscat		35.6	2.7	2.4	2.6				20.3	19.0	16.9	46.4	5.84	0.37	0.03	44.8
Victoria		38.3	1.7	1.5	2.5				20.3	19.0	16.9	46.4	5.97	0.38	0.03	44.8
Chișmiș moldovenesc		37.9	1.3	1.2	2.8				20.2	18.9	16.8	46.4	5.92	0.34	0.03	44.5
Arcadia		38.1	1.4	1.2	2.8				20.2	18.9	16.8	46.4	5.93	0.39	0.03	44.5
Lora		37.3	1.6	1.4	2.7				20.3	19.1	16.9	46.4	5.82	0.38	0.03	44.7
Prezentabil		37.2	3.0	2.6	2.5				20.2	18.9	16.8	46.4	5.91	0.37	0.03	44.7
Tudor		36.6	3.0	2.6	2.6				20.2	18.9	16.8	46.4	5.92	0.35	0.03	44.7
Average		37,1			2.6				20.3	19.0	16.9	46.4	5.9	0.4	0.03	44.7
Vineyard agricultural residues, technical grape varieties																
Cabernet	Pruning	34.8	1.1	1.0	2.2				19.7	18.5	16.4	46.6	5.90	0.83	0.05	44.5
Sauvignon		34.9	1.6	1.4	2.1				19.6	18.4	16.3	46.6	5.80	0.81	0.04	44.6
Merlot		35.0	2.3	2.0	3.0				19.5	18.3	16.2	47.2	5.83	0.86	0.02	43.1
Pinot noir		33.8	1.5	1.3	2.7				19.6	18.3	16.3	47.1	5.81	0.81	0.02	43.5
Izabelgla		35.5	2.8	2.4	2.9				19.4	18.1	16.0	45.1	5.91	0.84	0.02	45.2
Traminer		34.5	2.2	1.9	2.5				19.7	18.4	16.3	46.4	5.85	0.83	0.05	44.4
Aligote		34.9	2.5	2.2	2.5				19.6	18.3	16.2	46.4	5.75	0.78	0.04	44.6
Chardonnay		34.6	2.7	2.4	2.5				19.7	18.5	16.4	46.4	5.85	0.77	0.04	44.5
Rcatsiteli		35.3	2.8	2.5	2.5				19.7	18.4	16.3	46.4	5.84	0.81	0.05	44.4
Savignon blanc		34.9	2.6	2.3	2.5				19.5	18.3	16.2	46.4	5.83	0.81	0.05	44.4
Muscat Ottonel		35.6	3.2	2.8	2.5				19.7	18.4	16.3	46.4	5.82	0.80	0.04	44.5
Media		34,9	2.3	2.0	2.5				19.6	18.3	16.3	46.5	5.8	0.8	0.04	44.3
Notations used in the table: M _{r.av.} – The average moisture content at harvest; σ – Standard deviation; CI – Confidence interval; A _{d.av.} – The average ash content; A _{av. M=10%} - The average ash content of biomass with 10 % moisture; q _{v.gr.d} – High calorific value; q _{p.net.d} – low calorific value at constant pressure (d.b.). q _{p.net.m=10%} – low calorific value at 10% moisture.																

The ash content was less than 1.7% for all the wooden residues which resulted from orchard pruning; the average ash content was 1.3%.

The vine residues produce the highest quantity of ash after combustion, with an average recorded value of 2.6% for ten table grape varieties and 2.5% for eleven technical grape varieties

It was concluded that, considering the ash content criterion, all the orchard and vine residues may be used for producing DSBF in accordance with the ENPlus 3 requirements.

The lower calorific value (which, in our study, was calculated for a moisture content of 10% - $q_{p.net.m=10\%}$.) is an important characteristic which limits the use of certain types of biomass for producing ENPlus 3 certified DSBF.

Table 2 shows that the lowest calorific value was recorded for the herbaceous residues, with values between 14 MJ/kg for sunflower stems and leaves and 15.8 MJ/kg for maize cobs.

According to this criterion, all the types of orchard residues and vine residues from table grape varieties may be used for producing ENPlus briquettes and pellets; vine residues from technical grape varieties may be used as raw material for producing bio briquettes.

CONCLUSIONS

Based on the experimental results it was concluded that the herbaceous secondary products, with the exception of maize cobs, do not achieve the quality characteristics required by the ENPlus regulations; an in-depth analysis will indicate whether they are more useful for producing DSBF or as organic fertilizer. The analysis should take into account the technical, economic and social aspects, as well as the agricultural and environmental sustainability and durability.

Vine tendrils and orchard branches resulted from pruning may be used for producing ENPlus certified DSBF, when used in blends and mixtures.

Some herbaceous secondary products may be used in blends with the orchard and vine residues, but only after a laboratory analysis of the

raw materials or of the final product; the analysis should also take into account the technical and economic aspects and the impact on the agricultural and environmental sustainability and durability.

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STUDIES REGARDING THE INFLUENCE OF SOME PHENOTYPIC PARAMETERS ON RAW MATERIAL'S QUALITY OF DIFFERENT GENOTYPES FROM *MENTHA* GENUS

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Abstract

Peppermint (*Mentha sp.*) is one of the most cultivated medicinal plant worldwide due to its diverse range of products in which it can be used. The main natural product (*Herba Menthae*) is used in pharmaceutical industry, as an additive and flavor in food industry and the extracted essential oil is used in numerous cosmetic and selfcare products. This study's purpose is to quantify a series of biometrical and physiological elements of some species which pertain to *Mentha* genus from USAMV's "Collection of Medicinal Plants", which influence the raw material's quality and the quantity of essential oils. The studied mint species are *Mentha viridis* var. *crispata* (Schrod) Beck Ecotype 2, *Mentha longifolia* (L.) Hudson Ecotype 2, *Mentha spicata* var. *viridis* L., *Mentha longifolia* (L.) Hudson Ecotip 1, *Mentha viridis* var. *crispata* (Schrod) Beck Ecotype 1. The study followed the influence of the leaf surface, the content of chlorophyll pigments, but also the total leaf number on the production of volatile oil. Being a very important parameter in the reception and estimation of needed quantity of raw material, drying efficiency was determined for each cultivar. The highest amount of volatile oil was obtained from two ecotypes of the *Mentha viridis* var. *crispata* (Schrod) Beck species, in a percentage of 0.54% and 0.58%, and the lowest amount from *Mentha longifolia* (L.) Hudson Ecotype 2. The results are showing that the quantity of volatile oil is influenced by the leaf surface, especially by the basal leaves. It is being proved that the amount of the volatile oil is influenced by the leaf surface, its placement and the chlorophyll pigments content and the cultivar factor, in the same environmental conditions.

Key words: *Mentha* spp., chlorophyll pigments, volatile oil, leaf surface

Peppermint (*Mentha* spp.) is one of the most important and cultivated medicinal plants from Romania, idea proved also by the fact that the first attempt of introducing it in culture was in Cluj in 1988 on a surface of 88 m² (Munteanu *et al*, 2016). The first peppermint crop was in 1929, on a surface of 5 ha in Bod, with seedlings from England (Păun *et al*, 1988).

The crop's importance is given especially by the aerial part (*Menthae herba*), but also by the essential oil extracted through hydrodistillation (*Menthae aetheroleum*), oil which has approximately 47-73.6% menthol in its composition (Cucu *et al*, 1982).

The concentration and chemical composition of essential oil vary depending on species and pedo-climatic conditions, some varieties containing up to 40 components. The peppermint essential oil is the 2nd most sold volatile oil extracted from plants, after the lavender essential oil.

The main method for extracting essential oil is using the water vapors. The big production

countries (India, China) use this method for its convenient efficiency/quality ratio.

Peppermint species have numerous uses: pharmaceutical industry (antispastic, choleric and carminative effect), (Stănescu *et al*, 2014), food industry (antimicrobial and antioxidant activity, flavor enhancer in food and beverages), (Gobert *et al*, 2002, Preedy *et al*, 2016), pesticide (antifungal activity for *Fusarium* and *Pyrenophora graminea*), (Kurita *et al*, 1983) and many other uses in aromatherapy, aromatizing the tabaco, personal hygiene products and veterinary medicine (Robu *et al*, 2004).

The purpose of this research is to quantify some physiological parameters (leaf surface, content in chlorophyll pigments). Chlorophyll pigments are directly involved in the photosynthetic process and indirectly in the qualitative and quantitative content of essential oil (Burzo *et al*, 2013). Through the utilized method we tried to demonstrate how these factors influence the essential oil content in some peppermint (*Mentha sp.*) ecotypes. Drying is the

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most common and fundamental method for preserving the medicinal plants after harvesting because it allows the rapid preservation of the medicinal qualities of the plant material in a simple way (Müller Joachim, 2007). For this reason, we have realized a dynamic of natural drying to determine the drying yield, a very important factor in estimating the production and ensuring the necessary quantity of raw material.

MATERIAL AND METHOD

The research was conducted in USAMV's "Collection of Medicinal and Aromatic Plants". The 5 ecotypes of peppermint were placed in plots with a surface of 2.5 m² (2.5x1 m), using it during the flowering for most of the determinations. Leaf surface, a determinant factor in bioactive compounds synthesis, was determined during the flowering of mint using the AM 350 Area Meter dispositive.

The content of chlorophyll pigments was determined in two ways: once, using the portable device Opti-Sciences CCM-200 plus, directly in the field, and in the laboratory using the UV-1700 Spectrophotometer. For this method, we weigh in 0.5 grams of fresh mint leaves, grinding it and mixing with 80% concentration acetone. The obtained product is filtered using a Duran filter with 3 (16-40) μm porosity and after introduced in the spectrophotometer for analysis (Jităreanu *et al*, 2007). The processing of qualitative and quantitative data was done using the Lichtenthaler 1987 method.

Statistical processing of data resulting from biometric measurements was performed using the variance method and analysis of variance. The obtained results were processed by calculating the limit differences for the probability of transgressions of 5%, 1% and 0.1% (Jitareanu *et al*, 2006).

RESULTS AND DISCUSSIONS

The data obtained shows that in the case of leaf distribution at the 5 mint ecotypes it is differently distributed. For example, *Mentha longifolia* (L.) Hudson (ecotype 1, 2) have the leaf surface placed mostly in the middle part of the plants and in the case of those producing a large quantity of oil (*var. crispata*) the leaf surface is situated more at the base of the plant (*figure 1*).

For some species it is considered that the number of the leaves is directly proportional with the quantity of assimilated substances found in plant. At the studied peppermint ecotypes (table 2),

graphically represented in figure 2, it can be observed that this rule is not applying.

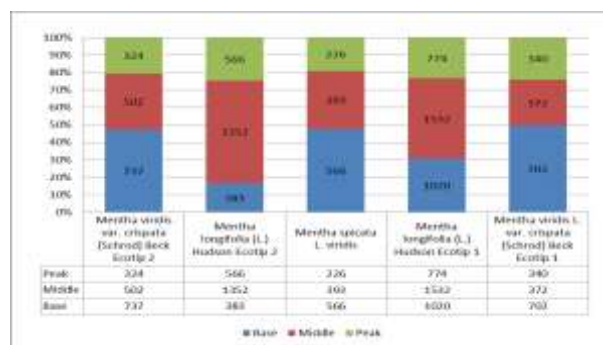


Figure 1 Distribution of the foliar surface at plant level

After the statistical processing it is obvious that regarding the ecotypes with a reduced number of leaves the difference is significant but negative and it's present in ecotypes with a high amount of volatile oil. The ecotypes which have 23 and 26 leaves have produced the largest amount of volatile oil.

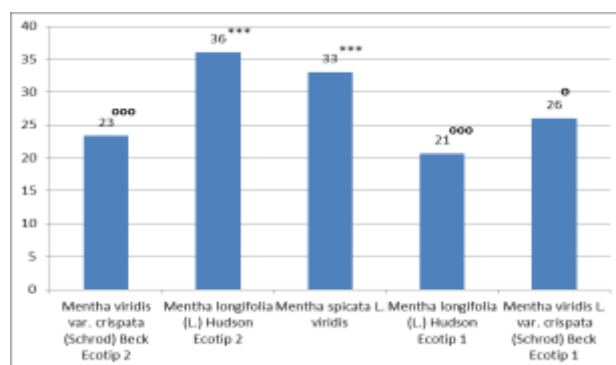


Figure 2 Leaf number for every species

For the statistical processing of the data obtained, the average of the 5 ecotypes taken in the study was used as a control. Positive differences significantly distinct were obtained on *M. longifolia* (L.) Hudson ecotype 2 și *M. spicata* L. viridis ecotypes and significantly distinct differences but negative for *M. viridis* var. *crispata* (Schrod) Beck ecotype 2 și *M. longifolia* (L.) Hudson ecotype 1 ecotypes.

Table 1

Leaf number for every species				
Variant	Number leaf	Differences		Significance
		%	Nr./pl.	
<i>Mentha viridis</i> var. <i>crispata</i> (Schrod) Beck Ecotip 2	23	83.81	-4.5	ooo
<i>Mentha longifolia</i> (L.) Hudson Ecotip 2	36	129.5	8.2	***
<i>Mentha spicata</i> L. viridis	33	118.71	5.2	***
<i>Mentha longifolia</i> (L.) Hudson Ecotip 1	21	74.46	-7.1	ooo
<i>Mentha viridis</i> L. var. <i>crispata</i> (Schrod) Beck Ecotip 1	26	93.53	-1.8	o
Average	27.8	100	0	Control
	DL5%	1.8 Nr/pl		
	DL 1%	2.6 Nr/pl		
	DL 0.1%	3.8 Nr/pl		

Using the CCM-Opti Science device were obtained the content in chlorophyll pigments of

different foliar floors in the moment of flowering and the obtained data were graphical represented in figure 3.

It is noticed that at most ecotypes the highest content in chlorophyll pigments is in the upper leaf floors and the lowest content at the base of the plants. The highest values of upper leaves were between 45.9, 28.3 in the case of *Mentha viridis* var. *crispata* (Schrod) Beck and 11.6 – 19.1 at *Mentha longifolia* (L.) Hudson ecotype 2 and *Mentha spicata* L. var. *viridis*.

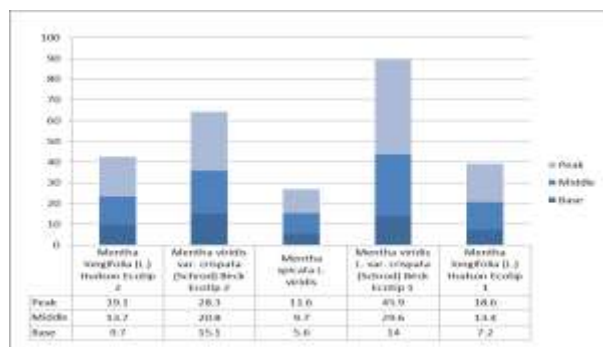


Figure 3 Determination of the content in chlorophyll pigments with CCM - 200 plus

By analyzing the quantity of chlorophyll content using the spectrophotometer it can be highlighted that the highest amounts of chlorophyll a and b are showing at the two ecotypes of *M. viridis* var. *crispata* (Schrod) Beck. (figure 4)

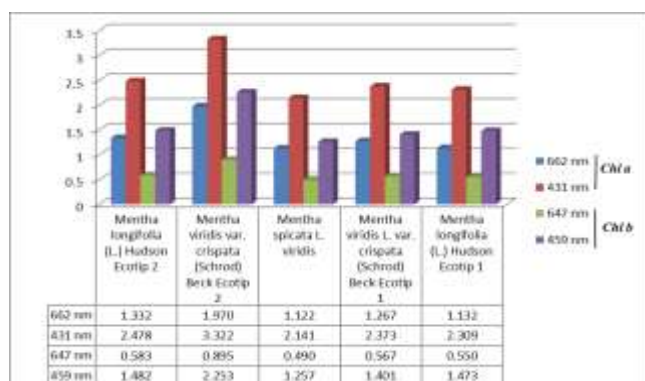


Figure 4 The qualitative content of chlorophyll pigments

Regarding the quantity of chlorophyll pigments calculated through the Lichtenthaler method, the data from table 2 highlight that the two ecotypes of *M. viridis* var. *crispata* (Schrod) Beck have the highest amounts of chlorophyll pigments, between 21.427 mg/g fresh material (ecotype 2) and 13.816 mg/g fresh material (ecotype 1).

Similar differences were observed for chlorophyll b at the same two ecotypes.

Table 2
The quantitative content of chlorophyll pigments

	Chlorophyll a (mg / g fresh material)	Chlorophyll b (mg / g fresh material)	Total chlorophyll	Ratio a/b	Carotene (mg / g fresh material)
Mentha longifolia (L.) Hudson Ecotype 2	14.605	5.777	20.376	2.528	3.400
Mentha viridis var. crispata (Schrod) Beck Ecotype 2	21.427	9.282	30.700	2.308	4.797
Mentha spicata L. viridis	12.328	4.833	17.157	2.551	3.003
Mentha viridis L. var. crispata (Schrod) Beck Ecotype 1	13.816	5.780	19.590	2.390	3.169
Mentha longifolia (L.) Hudson Ecotype 1	12.271	6.077	18.343	2.019	5.716

Analyzing the carotenoids content it can be observed that it has higher amounts in *Mentha longifolia* (L.) Hudson (ecotype 1) with a value of 5.716 mg/g green material, followed by ecotypes 1 and 2 of *M. viridis* var. *crispata* (Schrod) Beck (figure 5).

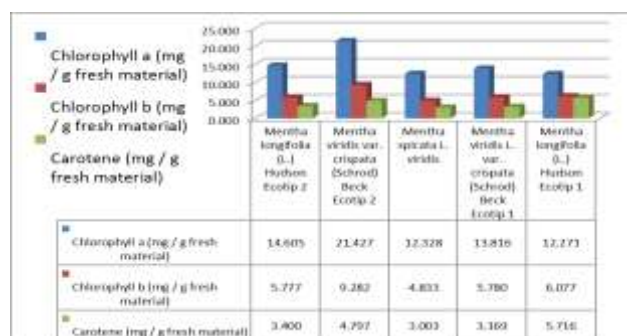


Figure 5 The quantitative content of chlorophyll pigments

The determinations have a direct influence on the quantity of volatile oil. The highest amount of essential oil is in ecotypes 1 and 2 of *M. viridis* var. *crispata* (Schrod) Beck with values between 5.8 ml/kg in ecotype 2 and 5.4 ml/kg at ecotype 1. The data are presented in figure 6.

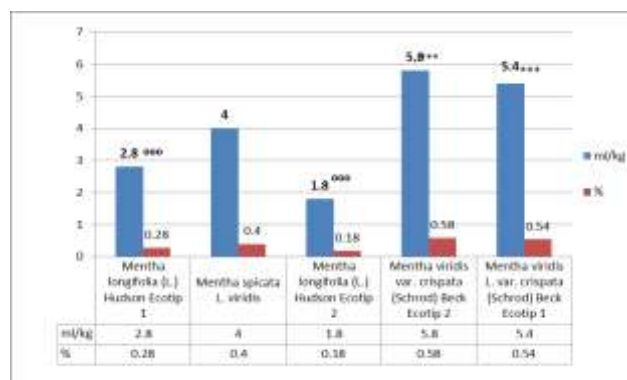


Figure 6 Content in essential oils

Table 2

Content in essential oils

Variant	Production ml/kg	Difference		Significance
		%	ml/kg	
Mentha longifolia (L.) Hudson Ecotype 1	2.8	70	-1.2	ooo
Mentha spicata L. viridis	4	100	0	
Mentha longifolia (L.) Hudson Ecotype 2	1.8	45	-2.2	ooo
Mentha viridis var. crispata (Schrod) Beck Ecotype 2	5.8	145	1.8	***
Mentha viridis L. var. crispata (Schrod) Beck Ecotype 1	5.4	135	1.4	***
	Average	4	100	0
	DL 5%	0.3		Control
	DL 1%	0.4		
	DL 0.1%	0.6		

For some studied ecotypes of *Mentha* genus there is a positive correlation between the chlorophyll pigments content determined with CCM-opti Science device and the content of volatile oil determined through hydrodistillation (figure 7).

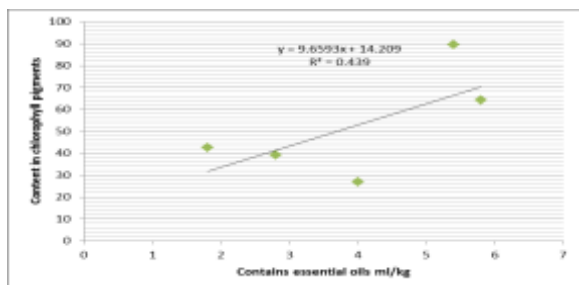


Figure 7 The correlation between the content in chlorophyll pigments and that of the essential oil

The drying dynamics and the fresh herb/dried plant ratio is a important parameter and it's different depending on species. The drying yield was different at every ecotype, the highest being on *Mentha logifolia* (L.) ecotype 1 (1:2:9) and the lowest on *Mentha longifolia* ecotype 2 și *Mentha viridis* var *crispata* (Schrod) Beck. A very important factor in drying dynamics and drying yield was the leaves's consistence and the thickness of the drying layer (figure 8).

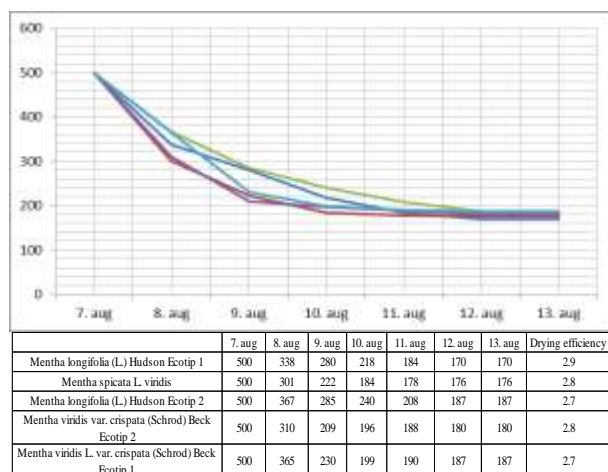


Figure 8 Drying dynamics of mint herb

CONCLUSIONS

The studied factors influenced the content in volatile oil. The foliar surface didn't have a major involvement, it's value doesn't reflect in ecotypes with the highest amount of volatile oil. The electronic determination of the pigments (CCM-200), the high amount of pigments from the upper

floors of the plants had a influence in volatile oil synthesis.

The spectrophotometer determination of quality and quantity of chlorophyll pigments highlighted that there is a positive influence in volatile oil accumulation.

ACKNOWLEDGMENTS

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PRODUCTIVITY AND CONVERSION OF SOWN GRASSLANDS IN THE PLAINS AREA OF BANAT

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Abstract

The sown meadows, consisting of complex mixtures of grassland grasses and legumes species ensure a high level of production, a high quality of feed, an important source of biological nitrogen, which ensures the protein autonomy of the forage system. The paper highlights the influence of the structure of some perennial grasses and legumes, sown in the plains area, on the production of plant dry matter, on the use of the sown grassland, on the conversion into animal products and on the economic efficiency of the pratecosystem in relation to animals. Carried out studies have shown that sown grasslands, consisting of a complex mixture (*Lolium perenne* 30 % + *Festuca pratensis* 30 % + *Trifolium repens* 20 % + *Lotus corniculatus* 20 %), in the plains area, used for grazing with sheep, obtains, in average, about 9 t/ha feed dry matter, over 3200 l/ha milk production and very high milk quality (5.5 % protein and 8.0 % fat). The research results showed an increase of sheep's milk production in complex mixtures in both years of experience, compared to the mixture variant consisting only of grass species. The value of the quality indices of sheep's milk is higher, both in protein and fat, in the grazed variant, sown with a complex mixture of grasses and legumes, compared to the variant sown with only a mixture of grass species. In livestock farms, the complex sown grassland, consisting of several species of grassland grasses and legumes (multispecies) secures and makes the fodder system more efficient, ensuring both the constant increase of the feed value of the fodder and the increase of the quality indices of the animal products.

Key words: sown grassland, grasses and legumes grassland mixtures, mowing, grazing, sheep milk, milk quality

Sown or temporary grasslands are one of the most complex agro-ecosystems in agriculture, whose functionality and use are based on the soil-plant-animal-environment relationship (Dragomir *et al.*, 2009). The establishment of these cultures implies the knowledge of the following aspects: the agrobiological particularities of the component species from the floristic structure of the mixtures; establishing the types of mixtures according to the seasonal pedoclimatic conditions and the use of the sown or temporary grasslands (Dragomir, 2005; Moga, 1983; Motcă *et al.*, 1994; Popovici *et al.*, 1979). The use, productivity, quality and longevity of temporary grasslands are influenced by the degree of applied technology (Simtea *et al.*, 1980, 1992; Motcă *et al.*, 1988; Moga, 1987, Sauer *et al.*, 2004)

The paper highlights the influence of the structure of some perennial grasses and legumes, sown in the plains area, on the production of plant dry matter, on the use of the sown grassland, on the conversion into animal products and on the

economic efficiency of the pratecosystem in relation to animals.

MATERIAL AND METHOD

The research was carried out at the Research Center for Grasslands and Fodder Plants, within the University of Agricultural Sciences and Veterinary Medicine of Banat Timișoara, under the conditions of a cambic chernozem, weakly gleezed, moderate decarbonate, clay-loamy soil, with a low acidic soil reaction, in the surface horizons and alkaline in the underlying horizons.

In order to quantify the soil-plant-animal relationship, a complex experimental device was designed and developed, with the following experimental factors: A – Type of mixture (a1 – *Lolium perenne* 50% + *Festuca pratensis* 50%; a2 – *Lolium perenne* 50% + *Trifolium repens* 50%; a3 – *Lolium perenne* 50% + *Lotus corniculatus* 50%; a4 – *Lolium perenne* 30% + *Festuca pratensis* 30% + *Trifolium repens* 20% + *Lotus corniculatus* 20%); B – Type of use (b1 – mowing; b2 – grazing)

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Upon establishment of the experience, a general agrofond of complex fertilizers was applied, at a dose of 200 kg/ha. Nitrogen fertilizers were administered during the vegetation periods, at a dose of N150, in different phases: N50, at the beginning of vegetation, N50, after the first mowing or pasture cycle, and N50 after the next mowing or grazing cycle.

The grazing of the experimental variants was done with Țurcana sheeps, with a load of 2 UVM/ha.

In the two years of production, the following quantitative and qualitative parameters were determined: the production of dry matter, the milk production of sheeps and the value of milk quality indices.

For some production farms, the results obtained through efficient use of sown meadows

(pure culture and mixtures) grazed with sheeps, for the production of milk and meat are presented.

RESULTS AND DISCUSSIONS

Sown grasslands, consisting of simple or complex mixtures of grassland grass and legume species, are characterized by some important features: they provide a dense vegetable carpet, for a period of several years; it ensures a high level of production and a high quality of feed; the presence of legumes in the floristic composition is an important source of nitrogen, which can ensure the protein autonomy of the forage system; the robustness of the sown grasslands ensures a good self-regulation under stress or operating conditions.

Table 1

The influence of the type of mixture and sown grasslands method of use in the plain area of Banat, on the production of dry matter (1st year of production)

Type of mixture	Mowing		Grazing with sheep		Difference (mowing-grazing) (t/ha)
	t/ha	%	t/ha	%	
<i>Lolium perenne</i> 50% + <i>Festuca pratensis</i> 50%	7.00	88.2	6.54	80.9	0.46
<i>Lolium perenne</i> 50% + <i>Trifolium repens</i> 50%	8.20	103.2	8.39	103.8	-0.19
<i>Lolium perenne</i> 50% + <i>Lotus corniculatus</i> 50%	7.52	94.7	8.23	101.9	-0.71
<i>Lolium perenne</i> 30% + <i>Festuca pratensis</i> 30% + <i>Trifolium repens</i> 20% + <i>Lotus corniculatus</i> 20%	9.06	114.1	9.15	113.2	-0.09
Mixture average	7.94	100	8.08	100	-0.14

During the first year of production, all 3 types of simple mixtures studied, used by mowing, produced dry matter productions smaller than the complex mixture (consisting of *Lolium perenne* 30% + *Festuca pratensis* 30% + *Trifolium repens* 20% + *Lotus corniculatus* 20%), with 0.86 - 2.06 t / ha, with the lowest level at *Lolium perenne* 50% + *Festuca pratensis* 50% mixture. If we refer to the

average production of mixtures, it turns out that the complex mixture achieves the highest increase of dry matter, by 14.1% more. In the case of the use by grazing, it is found that in all mixtures of grasses and legumes a slight increase of the production of dry substance is obtained, compared to the mowed variants. However, the differences between the two modes of use are insignificant (Table 1).

Table 2

The influence of the type of mixture and sown grasslands method of use in the plain area of Banat, on the production of dry matter (2nd year of production)

Type of mixture	Mowing		Grazing with sheep		Difference (mowing-grazing) (t/ha)
	t/ha	%	t/ha	%	
<i>Lolium perenne</i> 50% + <i>Festuca pratensis</i> 50%	6.56	86.4	6.00	77.6	0.56
<i>Lolium perenne</i> 50% + <i>Trifolium repens</i> 50%	7.88	104.1	8.31	107.5	-0.43
<i>Lolium perenne</i> 50% + <i>Lotus corniculatus</i> 50%	7.16	94.6	7.66	99.1	-0.50
<i>Lolium perenne</i> 30% + <i>Festuca pratensis</i> 30% + <i>Trifolium repens</i> 20% + <i>Lotus corniculatus</i> 20%	8.73	115.3	8.94	115.6	-0.21
Mixture average	7.57	100	7.73	100	-0.16

In the second year of production, the overall level of dry matter production was lower than in the first year, due to the low level of precipitation

and their uneven distribution during vegetation. Among the mixtures studied it stands out also this year, the complex mixture, consisting of the two

species of grasses and the two species of legumes, which has achieved the highest yields, both at the variant used by mowing (8.73 t / ha SU), as well as the pasture variant with the sheep (8.94 t / ha SU).

In the second year, the differences in dry matter in all the studied mixtures, are in favor of grazing. (Table 2).

Table 3

Milk conversion of forage production of temporary grassland, used by grazing with sheep (3 grazing cycles)

Type of mixture	1st year of production		2nd year of production	
	l/ha	%	l/ha	%
<i>Lolium perenne</i> 50% + <i>Festuca pratensis</i> 50%	2936	100	2903	100
<i>Lolium perenne</i> 50% + <i>Trifolium repens</i> 50%	2826	96.2	2771	95.4
<i>Lolium perenne</i> 50% + <i>Lotus corniculatus</i> 50%	2668	90.8	2638	90.9
<i>Lolium perenne</i> 30% + <i>Festuca pratensis</i> 30% + <i>Trifolium repens</i> 20% + <i>Lotus corniculatus</i> 20%	3429	116.8	3145	108.3

The conversion into milk of sown grasslands production is the best method of efficient use of feed production, both through the production of milk obtained and by its quality. In the first year of production, the largest quantity of sheep milk (3429 l/ha) was obtained in the pasture variant sown with complex mixture, which achieved a production increase with 16.8% higher than the

pasture variant sown with simple mixture of grasses (*Lolium perenne* 50% + *Festuca pratensis* 50%). Also, of the two types of simple mixtures, we noticed the mixture made of 50% *Lolium perenne* + 50% *Trifolium repens*, which resulted in a higher production of sheep's milk, with 5.9% in the first year, respectively 5.0% in the second year (Table 3).

Table 4

The value of the quality indices of sheep's milk, in the conditions of grazing some grasslands grass and legume mixtures (%)

Type of mixture	1st year of production		2nd year of production	
	Protein	Fat	Protein	Fat
<i>Lolium perenne</i> 50% + <i>Festuca pratensis</i> 50%	4.91	6.60	4.67	6.53
<i>Lolium perenne</i> 50% + <i>Trifolium repens</i> 50%	5.30	7.90	4.92	7.22
<i>Lolium perenne</i> 50% + <i>Lotus corniculatus</i> 50%	5.18	7.36	4.88	6.98
<i>Lolium perenne</i> 30% + <i>Festuca pratensis</i> 30% + <i>Trifolium repens</i> 20% + <i>Lotus corniculatus</i> 20%	5.67	8.21	5.37	7.88

The presence of legume species, both in simple mixtures and in complex mixtures, favored the increase of the quality indices of sheep's milk during the two years of production (Table 4). Thus, the protein content of milk, in the first year of grazing, increased from 4.91%, to the mixture of *Lolium perenne* 50% + *Festuca pratensis* 50%, to 5.30%, to the mixture of *Lolium perenne* 50% + *Trifolium repens* 50%, to 5.18%, to the mixture of *Lolium perenne* 50% + *Lotus corniculatus* 50% and to 5.67% to the mixture of *Lolium perenne* 30% + *Festuca pratensis* 30% + *Trifolium repens* 20% + *Lotus corniculatus* 20%. The protein content in the second year increases from 4.67%, to the simple mixture of the two grass species, to 5.37%, to the complex mixture of the two grasses and two legumes studied.

Also, the fat content of milk has the same growth allure, both in simple mixtures, consisting of a species of grasses (*Lolium perenne*) and a

legume species (*Trifolium repens*, *Lotus corniculatus*), as well as the complex mixture. In the first year, in the complex mixture the fat content was 8.21%, compared to only 6.60% in the simple mixture of grasses, and in the second year the values were 7.88% in the complex mixture, compared to only 6.53% for the simple mixture of grasses.

CONCUSSIONS

In livestock farms, the complex sown grassland, consisting of several species of grassland grasses and legumes (multispecies) secures and makes the fodder system more efficient, ensuring both the constant increase of the feed value of the fodder and the increase of the quality indices of the animal products.

The research results showed an increase of sheep's milk production in complex mixtures by

16.8% in the first year and 8.3% in the second year of grazing. compared to the mixture variant consisting only of grass species.

The value of the quality indices of sheep's milk is higher. both in protein and fat. in the grazed variant. sown with a complex mixture of grasses and legumes. compared to the variant sown with only a mixture of grass species.

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INNOVATIVE METHODS IN THE TEACHING PROCESS: THE BOOMERANG MODEL

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Abstract

The starting point of this research is chapter 2.3. "Models for lesson planning" from the volume *Deutsch Lehren Lernen* 6 (Ende K., Grotjahn R., Kleppin K., Mohr I., 2013). In this section it is a description of the teaching process, which Jeremy Harmer (2007) called the "boomerang model". Because I noticed the German language learners have difficulty in understanding and in acquiring language structures and grammatical rules, and because they were inhibited to express themselves in a foreign language and made many grammatical mistakes, I introduced this method in the course. According to this model, the teacher motivates the students in the initial phase; it arouses interest and establishes a task, such as the correct application of prepositions (where? / wo and wohin in German). The advantage of this method is the development of autonomy in the learning process, and the discovery of the grammatical rules, of the linguistic means, necessary for the accomplishment of the work tasks which is coming naturally.

Key words: boomerang method, German language, teaching, education

The starting point of this research was the chapter 2.3. "Models for Lesson Planning" of the volume 6 *Deutsch Lehren Lernen* (Ende K., Grotjahn R., Kleppin K., Mohr I. 2013, p. 97-114). In this section it is a description of the teaching process, which Jeremy Harmer (Harmer J., 2007) called the "boomerang model". The learners have difficulty in understanding and acquiring language structures and grammatical rules, they are willing rarely to speak during the class, and they are still doing many mistakes after the phase of explanations and practice. According to this model, the teacher motivates the learners in the initial phase: the pretask phase (*Einstigsphase*) (Ellis, 2009); it arouses interest and provides a task, such as the correct application of the prepositions (*wo?* - *wohin?*). The learners, assisted by the teacher and the teaching materials, develop the language resources they need to perform the tasks. They discover for themselves the grammar rules, the linguistic means, which are needed to fulfill the tasks: the main task phase (*Erarbeitung*) (Ellis, 2009). They try to find out what causes the differences (*zum-zur*). In this example, this is related to the gender of the nouns and they need to write the article next to it:

Wie komme ich **zum** Postamt? / **das**

(How do I get to the post office? / the)

Wie komme ich **zur** Bushaltestelle? / **die**

(How do I get to the bus station? / the)

Wie komme ich **zum** Bahnhof? / **der**

(How do I get to the train station? / the)

The formulation of the rules leads to a learning autonomy: by the own discovery, a better retention of the rule becomes possible. At the same time, the information is better retained when the learned is recorded with its own terms and an individual representation.

The presentation of the work results is followed by a phase in which the class focus on the phenomena where difficulties in production have arisen or which they have not used correctly: the post task phase (*Ergebnissicherung*) (Ellis, 2009). This model (*figure 1*) is based on the concept of task orientation.

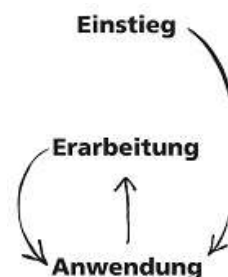


Figure 1 The Boomerang Model

This method leads to inductive recognition and the formulation of grammar rules and makes the learner aware of this learning strategy. With

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regard to the grammatical structures, we have followed this plan:

1. Collect example sentences
2. Arrange the corresponding sentence parts, so that the same is written among each other
3. Mark structure-relevant elements using the visualization techniques

MATERIAL AND METHOD

This is how I did the practical research project: I did the project in a student group at the university, where I teach German as a Foreign Language. The group consists of 28 participants. The course takes place once a week with 2 hours of lessons. The practical research of the project lasted for three weeks, with a total of 6 lessons.

We followed these steps in the implementation of this project:

1st step: 2 hours - linear lessons

2nd step: 3 hours - lessons according to the Boomerang model

3rd step: 1 hour - Evaluation: feedback from learners (questionnaire)

The exercises used were in particular:

Role-playing games, letters, autograph hunting, pantomime, phrases, interview questionnaire.

This is how I collected data and these are the instruments that we thought:

- Teacher observations
- Questionnaire for the learners (Figure 2)

The observations of the teachers referred to the following focus:

Speech improvement: using the structures used and the grammar rules that you have discovered yourself; if the participants understand the linguistic structures more easily

- Number of errors: if the students generally make fewer errors using this method

- Mood: if the participants are more active, more motivated, if they consciously notice that the lesson has been planned differently.

The questionnaire for the learners

During the last 3 German lessons I liked that ...	Y E S	N o	I don't know
We first practiced the linguistic structures and only then derived the theory.			
The participants could develop the grammatical rules.			
In the exercises and tasks we have practiced such speech situations that could also occur in our real life.			
We have discussed the difficulties and mistakes that			

4. Categorize the structure-relevant elements by introducing grammatical terms

5. Formulate the grammar rule and note the rule in an appropriate form

6. Check the rules found using further example sentences.

have arisen.			
After these 3 hours I noticed that			
I commit less mistakes through this method.			
I unconsciously appropriated the linguistic structures.			
I understood the grammatical rules faster.			
I participate more actively in the activities.			
I had much more fun with German lessons.			
I am much more motivated to develop my German language skills.			

Figure 2 Questionnaire for the learners

Thomas Unruh (2019) describes the meaning of a phasing of the course as follows: the phases of a lesson or lesson sequence that extends over several hours are like the chapters of a book. They structure the process, facilitate the overview, bring variety and tempo into the classroom, provide hold and rest points and thus opportunity for better orientation and new attention. A precise planning of individual phases makes it easier for the teacher to provide methodological diversity in the classroom and not to lose sight of the thematic thread of the hour. In addition, they provide the necessary transparency and sustainably ensure a growing planning competence on the part of most students.

Because everyone learns better, when they know what's going on, it's important to provide each phase of an hour with its own "chapter heading," which clearly indicates what the content is about in each phase and what that aspect is about the subject the hour has to do. It is worthwhile to formulate these topics of the individual teaching phases in a way that is suitable for students, so that they can present themselves (from the first grade on) under the respective headline.

RESULTS AND DISCUSSIONS

The data allow the following conclusions (figure 3 and figure 4). The use of the Boomerang method has the following advantages:

- The learners are more "in the thing" through the self-activity and connect the rules with their already existing grammatical knowledge, thereby

reactivating this and anchoring this process better in the memory.

□ The learners formulate the rule, how it is understandable to them and also the chance of better keeping is increased. It does not use a scientifically exact and all-encompassing rule, which nobody understands and keeps and which hardly promotes the linguistic competence.

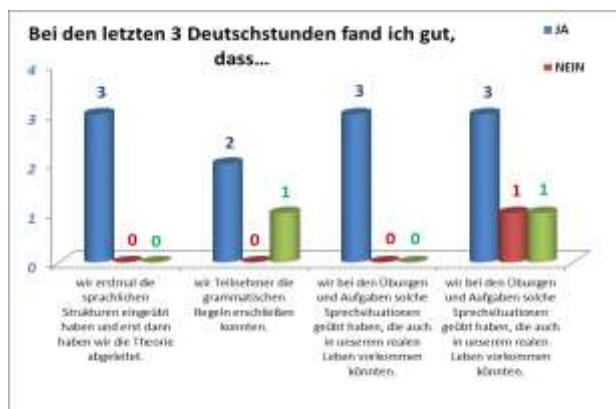


Figure 3 Obtained results 1

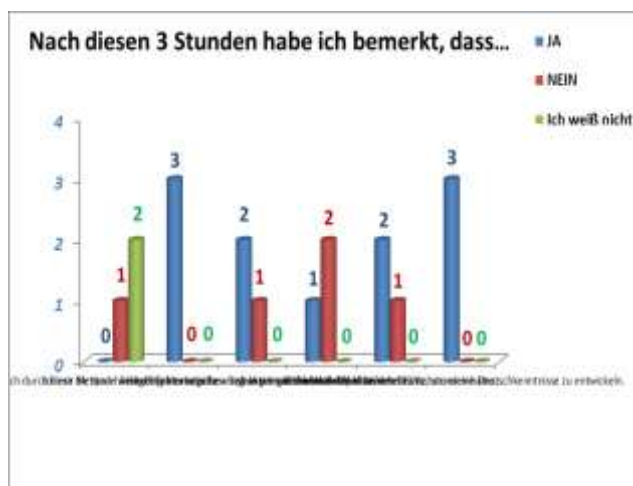


Figure 4 Obtained results 2

The Boomerang method represents a significant step towards understanding the functioning of the German language, the realization of a language awareness that can once again be a contribution to the development of a sense of language.

□ The learners made fewer mistakes / Incorrect: after 3 hours rather unrealistic.

□ They have become more active and motivated in the classroom

□ They have much more fun with the German lessons

□ They have practiced speaking situations that can also occur in their real life

□ They supported and helped each other

□ They have become aware of the difficulties and mistakes that have appeared in the exercises and tasks

□ They have consciously noticed that the lessons were planned differently.

CONCLUSIONS

I have personally learned from the evaluation of the practical research project in the team and from the reactions of the colleagues:

□ easy handling of the Boomerang model

□ unconscious appropriation and practice of the linguistic structures with discovered grammar - we save time with it

□ use of the language in life like speech situations

□ varied teaching design: more motivated attitude and more fun at German lessons.

New and perhaps unexpected, there are two things to this model of teaching:

1. The learners will develop their own linguistic and professional competence. They will receive support from the teacher through the formulation of the task, through the furnishing of learning materials and tools, through the moderating or supportive supervision during the preparation phase. The learners have a responsibility to plan, execute and monitor the task. This is how they train the key competences required at the beginning. In addition, learners introduce individual prior knowledge and internal differentiation regarding the difficulty of the task is possible.

2. However, this concept also supports the development of learners' language learning and autonomy: in the post-tasking phase and the presentation of the work results, the learners together or individually reflect on phenomena or difficulties encountered in the development. They also reflect on how they came to the results and what problem-solving strategies they used.

From our experience in dealing with this model, we could give more tips:

- There will not be all the phases in each lesson.

- Plan sufficient time for all the phases. Career beginners tend to extend the entry and motivation phase so that there is not enough time to work out.

- Always plan 15% more time than expected; there are always disruptions in the class that will delay you.

- For fast learners it is always good to have extra activities or additional materials prepared.

- Change in the rhythm is good for the learners.

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ASSESSMENT OF THE INTEGRATION MODE OF THE SUSTAINABLE DEVELOPMENT IN EUROPEAN RURAL AREA AND NORTH-EST REGION

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Abstract

Within the rural development, the agriculture of Romania holds an important weight, detaching itself by the contribution to the realization of the gross domestic product, as well as by about 29% of the employed population, returning 0.43 ha / inhabitant, compared to 0.21 ha / inhabitant in European Union. This explains why agriculture is a very attractive and profitable branch.

In this context, the strategy of sustainable rural development and the increase of the performance and the competitiveness of the agricultural production at national, regional or local level, must start from the economic-financial analysis of the situation of the agricultural sector, according to which to proceed to the adoption of those measures that lead, firstly, to the increase of agricultural production and, secondly, to its efficiency by attracting European funds.

The paper aims to identify the way of approaching sustainable development within the regional development strategies, having as a case study the North-East Region, and to evaluate the implementation of the strategic objectives, at regional level and in the rural environment. The main objectives come to meet the goal set by: the conceptual delimitation of sustainable development in a global, European and national context; assessing the dimension of the sustainable development phenomenon at global, European and national level; assessing the inter-correlation between the regional strategic objectives and the sustainable development objectives for the North-East Region (2007-2013 and 2014-2020); the projection of the evolution of the result indicators of the regional strategy for the period 2007-2020 (with target indicators for 2022), which highlights the contribution to ensuring regional and rural sustainable development, compared to the evolutionary trend from 2000-2013 and 2014-2020; identifying strategic proposals for ensuring regional and rural sustainable development.

Key words: rural, development, integration, sustainable, performance

Sustainable development is a model of development that aims to ensure a balance between economic growth, quality of life and environmental conservation in the medium and long term, so as to meet the needs of the current generation without compromising the ability to meet the needs of future generations.

The EU strategy set 7 key objectives: climate change and clean energy (limiting the effects of climate change on society and the environment); sustainable transport (limiting the impact of transport activities on society, economy and the environment); sustainable consumption and production (decoupling economic growth from the process of environmental degradation, social and environmental performance of technological processes, etc.); conservation and management of natural resources (improving management and avoiding overexploitation); public health (improvement of protection, performance of health

systems); social inclusion, demography and migration (inclusion, solidarity and increasing the quality of life); global poverty and challenges for sustainable development (promoting DD and integrating into global goals, meeting commitments). The paper thus aims to identify new strategic proposals for ensuring a sustainable development of rural areas, by using a system of specific, quantifiable and representative indicators that will allow, through econometric analyzes, the evaluation of the results and the projection of the evolution of the sustainable development phenomenon.

MATERIAL AND METHOD

Scientific documentation - by collecting information from different books, magazines, electronic sources and other materials, in libraries or other documentation centers, was the foundation of the research carried out, methods

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and techniques that allowed to identify the key issues, formulate hypotheses, outline objectives, achieve own research - said in order to confirm / deny the hypotheses and find solutions for the studied problem. Thus, the paper called for:

- the logical, rational interpretation of the concepts, phenomena and processes specific to the agricultural policy, as well as of the determinations and conditions that take place within it;
- explaining the evolutions and tendencies that are manifested in agriculture through the prism of the recourse both to the economic theory and to the statistical analysis and interpretation of the official data or calculated by the empirical observation or by the logical induction / deduction path;
- the use of a rich instrumental (tables, figures, graphs) for the most eloquent illustration and the most substantiated support of the opinions expressed and the conclusions of the research;
- comparative analysis of the evolutions recorded regarding the dynamics of pre- and post-accession agriculture;
- the critical study and interpretation of the bibliography - general and specialized, domestic and foreign - consisting both of monographs, treatises, specialized periodicals, normative acts, etc.;
- outlining trends in both European and Romanian agriculture;

Also, in order to achieve the set objectives, a series of indicators were established through which the association can highlight the directions of impact of the integration process on agriculture. The set of indicators has been selected starting from the identification and inventory of those quantifiable elements that can capture the impact of integration. These quantifiable elements have different particularities at the macroeconomic level than at the microeconomic level and require classification according to different criteria.

RESULTS AND DISCUSSIONS

The assessment of the sustainable development of the rural environment is an important issue in the elaboration and implementation of regional development strategies oriented towards ensuring smart growth, sustainable growth and inclusive growth. The low productivity of the rural economy sectors, the decrease of the employed population, the high unemployment among the young people, the increase of the number of people suffering from poverty and social exclusion, the lack of jobs, the reduced and poor quality infrastructure, etc. these are just some of the problems that the Romanian rural environment faces. (Bălăceanu C., Apostol D., 2012). These problems represent real

phenomena that characterize the rural environment, and the strategies of the last decades have focused on improving them in support of ensuring sustainable rural development and the growth of local economies. (Rusu M., 2012).

The document "CAP for 2020: How we respond to the challenges of the future related to food, natural resources and territories" presents the potential challenges, objectives and orientations (COM (2010) 672 final, 18.11.2010) from the perspective of a sustainable approach to the rural environment. Knowledge transfer and innovation in agriculture, as well as risk and natural resource management are key priorities for the common agricultural policy of EU Member States. Also, "Europe 2020: A European strategy for smart, sustainable and inclusive growth" (COM (2010) 2020 final, 3.3.2010) addresses issues regarding the efficient use of resources in the context of future climate challenges. (Oțiman P.I., 2012).

Sustainable development strategies aim to mobilize and concentrate the company's effort in achieving sustainable development, providing a framework for formulating a vision for a sustainable future, as well as a framework for negotiation, mediation, consensus and institutional capacity building processes. (Giurcă D., Alexandri C., Rusu M., 2012).

According to the European Sustainable Development Network (ESDN) in 2013, 26 countries had political strategic planning tools, of which only 23 had developed sustainable development strategies (*Table 1*). The strategies are very different, but they generally include a vision, three-dimensional objectives and describe the implementation process. Most strategies range from 50-100 pages, with the exception of Great Britain (7 pages) and Germany (252 pages), and three countries have opted for different approaches, namely Slovenia, Germany and the United Kingdom. The number of objectives varies from 32 in Estonia and Switzerland and 610 in Lithuania.

By creating these objectives, the 2020 Strategy aims to be compatible with the long-term development objectives of the European Union's Sustainable Development Strategy (SDD). Thus, the 2020 Strategy includes SDD objectives in terms of resource efficiency, levels set for climate and energy goals, poverty reduction, and educational attainment (*Table 2*).

Table 1

Strategies for sustainable development at European level

Contry	Year of first strategy	Updated versions	Other revisions	Number of objectives / measures	Predominant size (economic, social, environmental)	Other dimensions
Austria	2002	2011	-	159 (5/23/131)	Egal	International
Belgium	1999	2010	2000,2004	230 (6/31/193)	Social	
Bulgaria	2007 (draft)	-	-	-	-	-
Croatia	2009	-	-	-	-	-
Czech Republic	2004	2010	-	167 (6/17/144)	Egal	International Education
Denmark	2002	2009	-	200 (21/87/92)	Egal	Research
Estonia	2005	-	-	32 (4/12/16)	Egal	International
Finland	1998	2006	-	186 (6/26/154)	Egal	households
France	2003	2010	-	75 (9/50/16)**	Egal	Culture
Germany	2002	2012	2004,2008	25 (4/21/0)***	Egal	International Education
Hungary	2007 (draft)	2013	-	-	-	Research
Iceland	1996	2010	2002	72 (4/17/51)	Medium	community
Italy	2002	-	-	142 (4/28/110)	Medium	International Education
Latvia	2002	2010	-	319 (26/79/214)	Egal	Research
Lithuania	2003	2011	2009	610 (27/48/535)	Egal	
luxembourg	1999	2010	-	-	-	International
Malta	2006	-	-	246 (4/28/214)	Egal	-
Netherlands	2001	2011	2003,2008	89 (13/22/54)****	Egal	International
Poland	2000	-	-	-	-	
Portugal	2007	-	-	-	-	households
Romania	1999	2008	-	-	Social Economic	Tourism
Slovakia	2001	-	-	277 (11/28/238)	Social-Economic	Research
Slovenia	2005	-	-	169 (5/19/145)	Economic	Education
Spain	2007 (draft)	-	-	-	-	Household culture
Sweden	1994	2006	2004	119 (8/19/92)	Social	Tourism
Switzerland	1997	2012	2002,2008	32 (10/22/0)	Social Economic	Research
Great Britain	1994	2011	1999,2005	160 (6/33/121)	Egal	Education

Sursa: ESDN 2013

Table 2

Integration of the SDD key objectives into the Europe 2020 Strategy

Objectives SDD	Initiative						
	Smart growth			Sustainable growth		Inclusive growth	
	A digital agenda for Europe	An Innovation Union	Youth on the move	A resource-efficient Europe	An industrial policy for the age of globalization	An agenda for new skills and new jobs	A European platform for combating poverty
	1	2	3	4	5	6	7
Climate change and energy	25-75%	25-75%		over 75%	over 75%		
Sustainable transport	25-75%	25-75%		25-75%	25-75%		
Sustainable consumption and production	under 25%	under 25%		over 75%	25-75%		
Conservation and management of natural resources		25-75%		over 75%	25-75%		
Public health	25-75%	25-75%				under 25%	25-75%
Social inclusion, demography and migration	25-75%	25-75%	25-75%			over 75%	over 75%
Global poverty and the challenges of sustainable development				25-75%			25-75%

Sources: 2013 monitoring report of the EU sustainable development strategy, 2013 edition, Sustainable development in the European Union

The relationship of the EU's objectives to those of sustainable development can be summarized as follows:

- Socio-economic development: The 2020 strategy provides for "promoting a prosperous, competitive and eco-efficient economy, which offers high standards of living and full and high quality employment throughout the EU "; for this purpose it was established the increase of the expenses for R&D up to 3% of the GDP, the increase of the energy efficiency by 20% and the increase of the employment rate (20-64 years) to 75% by 2020; these objectives supported by initiatives 1-6 and the "Employment Package";

- Sustainable consumption and production - SDD objectives are - by addressing social and economic development within ecosystems and decoupling economic growth from environmental degradation, by improving environmental and social performance of products and processes, by increasing green public procurement and EU involvement in the global market. environmental technologies and eco-innovations; supported by initiatives 4 and 5;

- Social inclusion (creating a socially inclusive society and ensuring and increasing the quality of life of the inhabitants) - SDD objectives - poverty reduction, social and territorial cohesion, reduction of school dropout (under 10%, 85% of staff under 22 to graduate from secondary school) , restructuring of social systems, increasing the participation in the labor market of the elderly, inclusion of women in the labor market, attracting and participating immigrants in the labor market; initiatives 6 and 7; general objective to reduce school dropout below 10%;

From the analysis of the presented data it is observed that the gross domestic product per inhabitant realized in the North-East Region has the lowest level compared to the other regions in Romania, representing 61.4% of the value registered at national level of GDP / inhabitant in 2016.

In 2016, the contribution of agriculture to the regional GDP was 16.5%, a value higher than that achieved at the national level (10.6%), which denotes the high dependence of the regional agriculture economy. (Table 3).

Table 3

The gross domestic product of the North-East Region per inhabitant, by counties, between 2008 and 2016

The region	P.I.B. per inhabitant - millions of lei current prices								
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Northwest	6.538,1	8.783,8	11.068,4	12.538,6	14.946,6	18.610,5	21.542,1	21.297,4	21.827,2
Center	7.505,4	9.747,8	11.858,3	13.097,6	15.920,2	19.579,5	22.707,7	22.618,8	23.428,3
North East	4.970,9	6.575,9	7884,3	8.907,6	15.920,2	12.340,9	14.794,5	14649,3	15.014,8
South East	5.966,8	7.788,1	10.323,4	11.541,7	13.569,8	15.641,8	19.098,9	18.738,2	20.076,8
South Muntenia	5.562,7	7.377,4	9.506,8	11.068,5	13.374,6	15.757,8	19.648,1	19.913,7	20.288,2
Bucharest-Ilfov	14.467,0	17.639,0	21673,3	29.572,6	35.012,1	43.037,3	59.680,2	55.079,3	58.137
South West Oltenia	5.553,1	7.698,0	9.493,8	10.371,1	12.463,2	15.097,3	17.831,8	17.752,8	18.735,1
West	7.527,4	10.265,2	13.045,1	15.064,7	18.570,1	22.341,9	26.173,2	25.602,4	27.640
Romania	6.950,1	9.090,3	11.372,0	13.362,8	15.967,6	19.315,4	23.934,6	23.341,4	24.435,9

Source: Statistical Yearbook of Romania 2008-2016

Depending on the way the indicators are used in the regional analysis and the way in which the strategic objectives aim to improve them, we have further developed a matrix of the result

indicators that allows us to identify the logic of the strategic intervention in ensuring the sustainable development of the rural environment in the North Region. - East (Table 4):

Table 4

North-East Region 2007-2013 - Logic of the intervention of the sustainable development of the rural environment

Sustainable development objective	Infrastructure and environment	Business environment	Tourism		Rural development	Sustainable development objective
Structural transformations and macroeconomic equilibria						Increase of gross domestic product per inhabitant
						Increasing the number of active enterprises
						Increase the capacity of existing tourist accommodation
						Increased employment rate
						Lowering the unemployment rate
Sustainable transport						Increasing the length of public roads
						Decreasing the number of people killed in road traffic accidents
Sustainable production and consumption						Increased volume of water distributed
						Population connected to the wastewater treatment system
Conservation and management of natural resources						Increasing the quality of surface water
						Increased area of forestry per capita (ha)
						Limitation of harvested wood
Public health						Decreased death rate due to chronic diseases
						Decreased mortality rate
						Decreased infant mortality rate
						Increase the number of beds in hospitals to 1000 places
						Increasing the number of doctors to 1000 seats
Social inclusion, demography and migration						Lowering the poverty rate
						Decreased internal migration
Education and vocational training						Increasing the level of training of adults (25-64 years)
						Decreasing the early dropout rate of the education system by young people
						Growth of the employed population (15 - 64 years)
						Decreasing share of low education population
						Increasing the school population
Scientific research and technological development, innovation						Increased expenditure on research and development activities (% of GDP)
Increased labor productivity and improved employment rate						Increasing the share in GDP of development research expenditures in the enterprise / public sector
Investment policy and diversification of financing sources						Increasing the number of employees in the research activity

The analysis of the strategy highlighted that it does not address all the aspects of sustainable development, pursued at national level, not taking into account a series of indicators neither in the socio-economic analysis, nor in the strategic planning. (Otiman P. I., 2012). Of these we mention a series of objectives applicable to the rural environment:

- economic (measures to restructure the agricultural sector and agricultural marketing, decrease in the number of people in a household, decrease in consumption expenditure per household, increase in meat consumption per inhabitant, increase in the area cultivated

ecologically; increase the number of passengers benefiting from transport public etc.);

- environmental (quantities of waste collected per inhabitant, sanitation services, volume of water discharged, number of population benefiting from sanitation services and utilities; concrete measures of management of protected areas, etc.); (Otiman P. I., 2012).

- social (increasing life expectancy, increasing access to the population that gives up medical services for financial reasons, increasing life expectancy of people over 65, reducing accidents at work, reducing economic dependence, reducing gender pay disparities, etc.).

CONCLUSIONS

The Community Agricultural Policy proved to be one of the most successful communitarian policies, having also a high degree of complexity. Exactly this success shall determine the difficulty of the reform, considering the changes in the initial conditions that represented the fundament of its elaboration. The need to increase the competitiveness on the European Agricultural Market, the creation of an integrated rural development program to accompany the reform process, the simplification of the legislative framework at the European level and the substantial decentralization in implementing the measures shall lead to a reform in phases, whose effects shall mark the entire European construct.

The analysis per types of production of the separation per sources of incomes, revealed us that the support through Pillar I – subventions for the vegetal and animal production – was more equally distributed among farms. The contribution of the income sources to forming the total income emphasized that the value of the agricultural production leads to around 67.1% of inequity, the remaining being under the influence of subventions. Among these, the most important contribution was determined by the free payments (21,3%), these being followed by subventions for intermediary consumption and other subventions. The assessment of the effect of the modification of the income sources on the total income:

Incomes from the agricultural production and other subventions lead to the increase of inequity among farms that obtain different products (grains, wine, horticultural products, etc.); increase with 1% of the incomes from the agricultural production leads to the inequity increase with 5.76%;

The subventions lead, generally, to the decrease of inequity between them, especially subventions for the animal production (decrease of 3,33%) and direct payments (with 2,17%);

The analysis per types of specialized farms concerning the discomposure on income sources showed us that the value of the

agricultural production leads to 68.8% of inequity, the remaining ones being under the influence of subventions.

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STUDY ON EUROPEAN FINANCING IN THE FIELD OF PUBLIC FOOD AND TOURISM, AT THE LEVEL OF ROMANIA

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Abstract

Europe is today the culmination of its development, and European funding is the driving force behind the development of the economy of the Member States. The study aims to break down the economic phenomena related to the absorption of European funds and to analyze their evolution in the Multiannual Financial Frameworks (MFFs) 2007-2013 and 2014-2020. Methodologically, the research included a documentary analysis of some studies, reports, strategic documents and an empirical study based on the sociological investigation in the field of public food and tourism. The paper analyzed the impact of European funding at the level of Romania and the added value of European funds in the field of public food and tourism. The results of the study highlighted the major impact of European financing on economic development and the increase of the competitiveness of the economic sectors. The MFF 2007 - 2013 contributed to a great extent to the achievement of the proposed objectives. Thus, 9.4 million jobs were created, of which 42,000 research jobs were created, 0.4 million SME-s were created, access to road networks, railways, water supply increased for about 7 million people. In the current programming period (2014-2020) the European Commission aims to support specific areas such as economic, social and territorial cohesion, competitiveness for growth and jobs, administration, global Europe, sustainable growth; natural resources, security, and citizenship. For the next programming period, 2021 - 2027, the proposed budget amounts to 1.135 billion euros, representing the equivalent of 1.11% of the gross national income of the EU-27. The long-term objectives of the European Union are related to the single market, innovation and the digital sector, cohesion and values, natural resources and environment, migration and border management, security and defense, neighborhood and worldwide, European public administration. The case study conducted in the field of public food and tourism has revealed that although there are still barriers to accessing European funds (legislative, strict conditions imposed by specific guidelines, financial limitations) there is a high openness to the added value brought to the national economy by European funding.

Key words: EU funding, competitiveness, economic development

Europe holds the second most used currency in the world and is currently experiencing the largest innovation process in the context of the multinational research program "Horizon 2020" (European Commission, 2017).

At present, Europe is at the forefront of communication systems technology. In the context of globalization, the world population is permanently connected, the capacity of information transfer is greater than the capacity to adapt to the change of society.

In recent years, the European Union has made a significant contribution to the economic development of the Member States. The level of development of the Member States, in terms of accessing European funds, depends mainly on their ability to fully utilize the financial resources allocated (Horvat, 2005). Thus, the ability to absorb European funds is correlated with the power of a region to fully utilize the resources allocated from European funds efficiently and effectively (Kopeva *et al*, 2011). The specialized

literature reveals several studies on this topic. The essence of using European funds should be reflected in their impact on increasing competitiveness (Oprescu, 2006).

At the level of Romania, accessing European funds was a means to reduce economic and social disparities and to achieve economic and social cohesion (Pes and Porreta, 2016).

In the literature, we identify the opinions of the specialists proposing a reform of the EU budget. The views of specialists are mainly based on the reduced transparency of financial allocations (Le Cacheux, 2005; Cipriani, 2007; Fuest, Heinemann, Ungerer, 2015; Schratzenstaller *et al*, 2016).

Accessing European funds is the general framework for increasing the competitiveness of companies and obtaining positive economic results in each Member State.

In 2015, Mertinz and Potluka identify the mechanisms implemented by companies to be successful in the market: innovation (Regnoha

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and Lorincová, 2015, Audretsch *et al*, 2014, Triguero *et al*, 2014), export orientation (Mishra and Jaiswal, 2012, Chepte *et al*, 2014), low price

MATERIAL AND METHOD

Documentary analysis represents the method with the highest weight in the present paper. The study aims to decompose the economic phenomena related to the absorption of European funds and to analyze their evolution in the 2007-2013 MFF; 2014-2020.

The present study is based on an analysis of the strategic documents published by the European Commission during the period 2017-2018. These were analyzed according to the following criteria: accessibility of the text, relevance to the topic addressed, nature of the information extracted. Following the selection, the White Paper on the future of Europe and the way forward, document prepared by the European Commission in 2017, was the main starting point of the present study.

Depending on the phenomenon analyzed, to obtain a true and comprehensive result, we have attached major importance to the identification of the key elements that influence the absorption of European funds. Thus, they were analyzed deductively from the whole to the part, thus performing a deductive economic analysis. For example, we analyzed the financial allocation within the National Program for Rural Development (NPRD) 2014-2020, going along the line of its formation, with the highlighting of the main support measures related to the research field.

The empirical study includes a statistical survey based on a questionnaire, conducted to increase the relevance of the data presented. Thus, through the investigation, we set out to highlight the added value of European funds in the field of public food and tourism.

RESULTS AND DISCUSSIONS

The European Commission reports a negative situation regarding the unemployment rate and the aging of the population. Thus, one of the objectives of the EU was to ensure for each generation a more prosperous situation compared to the previous generation. We are at a time when the unemployment rate for the population under 25 is 18.6%, while at the level of the entire working population is 8.2%. Studies conducted at the level of the European Commission show that Europe today faces challenges related to a deep digitalization of society. Most of the current jobs did not exist a decade ago, and forecasts show that in the coming years new activities will emerge, for which, today, we cannot imagine the usefulness. Thus, the whole society must adapt to these changes, being necessary reforms at the political, economic, social, cultural, etc. level. Major

strategies (Dobson and Piga, 2013) and specialization (production / services) (Micic *et al*, 2014).

changes must take place at the level of the education system, which will ensure the preparation of future generations in this regard.

After the crisis started in 2008, a stagnation of economic progress was felt at the level of Europe. The crisis has led to the cancellation of large-scale projects leading to economic and structural deficiencies at the European level. Challenges at the level of the European Union have intensified, leading to the need for action strategies.

The MFF 2007 - 2013 contributed to a great extent to the achievement of the proposed objectives, such as (European Commission, 2017)

- 9.4 million people got a job;
- 8.7 million people have obtained a qualification;
- 95,000 research and innovation projects were developed;
- 42,000 research jobs were created;
- 400,000 small and medium-sized enterprises received support, creating a million jobs within them;
- access to improved water supply services for approximately 6 million people was facilitated;
- access to improved wastewater treatment services for 7 million people was facilitated;
- about 2,600 km of railway lines and 2,400 km of roads were built.

With the absorption of European funds, Member States began to accumulate technical progress, and the development cycle began with visible effects at local, national and international levels.

The expansion of financing possibilities for the Member States has led to general economic progress, contributing significantly to reducing disparities between states.

Whether we talk about the rural environment or the urban environment, the results of the implementation of the projects financed from European funds have contributed significantly to the economic growth of Romania, from the pre-accession period.

The programs proposed in the MFF 2014 - 2020 have received high attention from the Member States, as a result of the results obtained in the previous MFF.

The budgets granted in the MFF 2014-2020, by specific areas were:

- Economic, social and territorial cohesion - 371.4 billion euros;
- Competitiveness for growth and jobs - 142.1 billion euros;

- Administration - 69.6 billion euros;
- Global Europe - € 66.3 billion;
- Sustainable growth; natural resources - 420.0 billion euros;
- Security and citizenship - 17.7 billion euros.

European funding plays a major role in the development of the national economy. Given the numerous possibilities of accessing the European funds that Romania had in the 2014-2020 MFF, people with entrepreneurial spirit have managed to develop economic activities, thus contributing to improving the living conditions of the population.

Within the NPRD 2014 - 2020, the total public allocation is 9,441,583,798 euros, out of which payments of 3,617,295,228 euros were made. Analyzing the public data available on the website of the Ministry of Agriculture and Rural Development (MARD), we can see that 58,037 projects were submitted within the NPRD 2014 - 2020, and until May 2019, financing contracts for 32,026 projects were concluded. The total payments made by the EU so far are 3,617,295,228 euros (*table 1*).

Table 1

**The state of implementation of the NPRD 2014 – 2020
38/5000**

Selected projects		Contracted projects						Payments made
		Contracted projects (ongoing and completed)		Projects completed		Canceled projects		
No.	Value (euro)	No.	Value (euro)	No.	Value (euro)	No.	Value (euro)	
34,999	4,695,111.803	32,026	4,109,279,570	7,425	584,828,851	160	38,336,725	3,617,295,228

Analyzing the main sub-measures financed under the NPRD 2014 - 2020, it can be observed that the interest in accessing the European funds is high. Information on the main sub-measures funded through NPRD 2014 - 2020 was extracted from the report prepared by MARD.

In the NPRD 2014 - 2020, the rural population benefited from the support needed to develop the activities carried out. Whether we are talking about agricultural activities or non-agricultural activities, the financing possibilities have been numerous.

Table 2

The stage of implementation of NPRD 2014 - 2020 - the main measures related to the field of study

The stage of implementation of NRRD 2014 - 2020 - the main measures related to the field of study									
Submeasure	Selected projects		Contracted projects						Payments made - euro
			Contracted projects		Proiects completed		Canceled projects		
	No.	Value (euro)	No.	Value (euro)	No.	Value (euro)	No.	Value (euro)	
6.2 "Support for setting up non-agricultural activities in rural areas"	1,892	111,320,000	1,852	108,958,000	243	13,830,000	10	580,000	80,605,904
6.3 "Support for the development of small farms"	10,878	163,170,000	8,896	133,398,750	1.657	24,855,000	12	180,000	95,410,376
6.4 "Investments in the creation and development of non-agricultural activities"	985	162,489,275	879	145,839,564	237	30,889,526	32	4,647,008	56,436,285
19.2 "Support for the implementation of actions within the local development strategy"	4,903	287,368,967	4,877	286,077,780	538	34,391,138	26	1,186,621	106,123,271

Source: MARD

European funding has been a means of developing economic activities in rural areas in recent years. Through accessing European funds, companies have invested in intelligent business management systems. Thus, rural companies have become more competitive, managing to face the new challenges at the national and international level.

Related to the field of study, within the NPRD 2014-2020 support for public food and tourism was granted through the following sub-measures: 6.2 "Support for setting up non-agricultural activities in rural areas"; 6.3 "Support for the development of small farms"; 6.4 "Investments in the creation and development of non-agricultural activities"; 19.2 "Support for the implementation of actions within the local development strategy". The total public allocation was 724,348,242 euros, being made until May 2019, payments amounting to 338,575,836 euros (table 2). The large number of projects submitted highlights the interest of the contractors for this field of activity.

Analyzing the data in Table 2, we find that a significant number of projects were terminated. This can be correlated with the poor information of the applicants of the European funding. In most cases, failure to comply with the conditions to be met leads to their failure to comply and termination of financing contracts.

Due to the support programs for the activity in the rural area, we are talking today about companies with modern technical capital, which provide jobs for the population in the rural area and constantly contribute to the growth of the local economy.

In 2017, the EU Financing Guide for the tourism sector (2014 - 2020) was developed at the EU level. Within this strategic document, all the financing possibilities for the tourism sector were presented between 2014 and 2020.

Within the EU Financing Guide for the tourism sector (2014-2020) were presented the most relevant programs for the tourism sector within the EU:

The European Fund for Strategic Investments supports the following actions in the field of tourism:

- transport infrastructure;
- investments in the energy efficiency of tourist resorts and hotels;
- revitalizing the deactivated industrial areas by transforming them into areas where recreational activities can take place;
- financing of SMEs in the field of tourism;

- investment platforms dedicated to tourism.

ERDF - supports investments for:

- research activities in tourism;
- development of IT products for tourism - applications, databases;
- innovation of tourist services;
- diversification of the offer of tourism products and services;
- supporting cooperation in all industries in the tourism sector - setting up clusters;
- supporting regional development by ensuring the link between the inland and coastal regions;
- improving the energy efficiency of SMEs active in tourism;
- supporting entrepreneurship in the field of tourism.

In the MFF 2021-2027, the European Commission intends to invest in the following strategic areas:

- the single market, innovation and the digital sector - 187.4 billion euros;
- cohesion and values - 442.4 billion euros;
- natural resources and environment - 378.9 billion euros;
- migration and border management - € 34.9 billion;
- security and defense - 27.5 billion euros;
- Neighborhood and the whole world - 123 billion euros;
- European public administration - 85.3 billion euros;

European funding is the driving force behind economic development. In recent years, through the absorption of European funds, there has been a significant expansion of the key sectors of the national economy.

To increase the relevance of the present study, we conducted a sociological survey based on a questionnaire. Thus, the questions were addressed to 15 economic agents from the North-East and South-East Development Regions, who accessed European funds through NPRD 2007-2013, NPRD 2014-2020, Regional Operational Program (ROP) 2007-2013 and ROP 2014 - 2020.

Of the 15 respondents to the questionnaire, 58% accessed European funds in the present MFF (2014-2020). We also highlight in this context that the number of applicants for European funds has increased significantly compared to the previous MFF (*Figure 1*). The opening towards the support programs is mainly due to the success that the applicants had during the period 2007 - 2013.

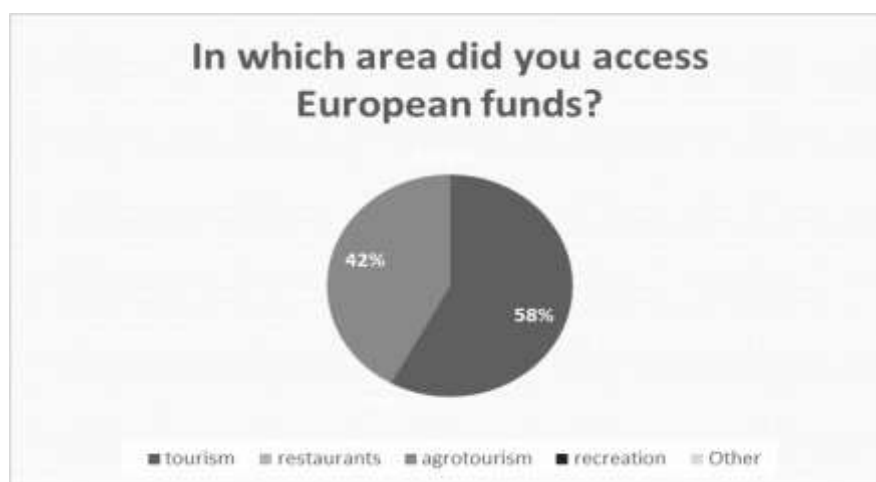


Figure 1 Group of respondents by area of accessing European funds (%)

Of the 15 respondents, only 17% did not encounter difficulties in accessing the European funds, while 33% had difficulties caused to limit the possibilities of limiting co-financing for investigations. A weight of 25% of the respondents and the difficulties in the legislative matters are

encountered, and 17% encounter difficulties related to multiple criteria and selection conditions imposed by the guide (figure 2). The study answers to the category of care of the beneficiaries to overcome the use of the barrier.

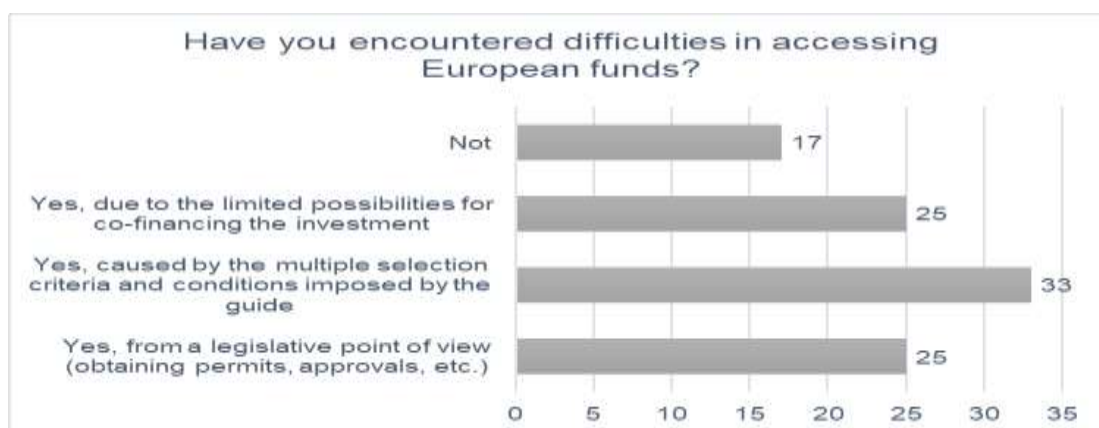


Figure 2 Group of respondents according to the difficulties encountered in accessing European funds (%)

Of the 15 respondents to the questionnaire, 42% stated that there is a high degree of appreciation from the clients that the infrastructure is created by accessing European funds (figure 3).

Given that access to European funds is strictly conditional on compliance with a set of principles, the infrastructures created correspond to international standards.

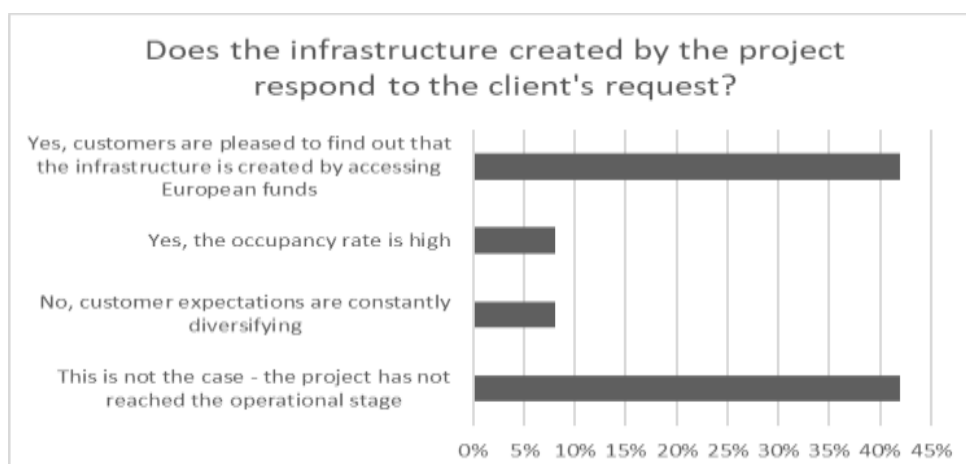


Figure 3 The degree of coverage of the market requirements of the infrastructures created by accessing the European funds(%)

Of the 15 respondents, 67% said that they intend to submit a new European project (Figure 4). This openness to European funding shows a tendency to develop the activity in the field in the next period. The opening towards the absorption of

European funds is based on previous experience and successful business models promoted at the national level by the Representation of the European Commission in Romania.



Figure 4 Grouping of respondents according to the intention of submitting a new European project

In the context of the next programming period, we anticipate a high interest of the economic actors in the field of public food and tourism to attract a large volume of European funds.

The ability of European funds to generate economic development will mainly depend on the use of funds efficiently and effectively.

At the national level, during the two programming periods (2007-2013; 2014-2020) important progress was made, creating jobs and development opportunities for young people.

CONCLUSIONS

In the MFF 2007 - 2013, objectives were achieved such as job creation and population specialization, supporting research infrastructure; supporting small and medium-sized enterprises, facilitating access to improved water supply services, wastewater treatment services, construction of roads and railways, etc.

Analyzing the public data available on the website of the Ministry of Agriculture and Rural Development (MARD), we highlighted that 58,037 projects were submitted within the NPRD 2014 - 2020, with financing contracts for 32,026 projects being completed by May 2019. The total payments made by the EU so far are 3,617,295,228 euros.

In the MFF 2014 - 2020, there were numerous possibilities for financing the public food and tourism sector, in this regard, we mention sub-measures 6.2 "Support for setting up non-agricultural activities in rural areas" and 6.4 "Investments in the creation and development of

non-agricultural activities", as well as other support programs.

According to the forecasts made by the European Commission in the MFF 2021-2027, the European Union will allocate 442.4 billion euros for cohesion and values (over 30% of the EU budget for this programming period). The growth and development of the Member States will continue to be a priority in the long term future.

The sociological survey based on the questionnaire made revealed that there is a great openness to the absorption of European funds and a confidence of the population in the positive effects generated by them.

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THE ALCMAEON PROJECT: BRINGING HUMANITIES, THE ARTS AND MEDICAL EDUCATION TOGETHER

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Abstract

The article is a systematic reflection on the Alcmaeon European project (2018-ES01-KA203-050606), which puts forth an alternative model for integrating the history of medicine into medical education. The project is developed within a partnership between education organizations, museums and universities from Spain, Great Britain, Italy, Greece and Romania. The project aims at shifting the focus of teaching the history of medicine from simply chronicling events to examining the process of medical development over time and studying it as a continuous inquiry by providing medical professionals with structured and harmonized online materials available in its own virtual museum and library. In addition, the arts can be used as a means to educate students of medicine in an agreeable atmosphere by means of focused interpretation and discussion with a view to developing their professionalism, self-awareness and communication skills, increasingly important assets for physicians. Bringing these disciplines together enables students to form deeper connections with patients and develop empathy and creativity. Overall, the focus group analysis highlighted that integrating the history of medicine into medical education is necessary as it gives students insights into past procedures and achievements, raises their awareness about the importance of medical and social ethics, provides lessons in medical education, empathy, charity work, community involvement, ethical standards, and laboratory research.

Key words: medical education, arts, the history of medicine, focus group

The teaching of the history of medicine is generally included in the programme of Medical Humanities courses for undergraduate medical students. This meets a need to connect medical history with medical practice. In fact, the perspective of humanities and social sciences enriches medicine with a human dimension that seems to have been lost. The history of medicine and medical humanities inform medical students about former physicians' efforts and contributions and introduce them to the evolution of medicine with its changes, breakthroughs and errors throughout the ages.

The Alcmaeon project represents an alternative model for integrating the history of medicine into medical education. The project's main outputs address medical humanities lecturers, medical education researchers, undergraduate medical students, curators of museums and medical libraries and museum visitors. The project

aims at changing the focus of teaching the history of medicine from chronicling events to examining the process of medical development over time and studying it as a process of continual inquiry. A thorough history of medicine helps students understand it in its proper context and provides them with new perspectives on its directions and progress. It offers students great examples of learning: it tells them how our ancestors worked and sought to evolve as we do today; it makes medicine more human, more sensitive, more interesting and more accessible to future young physicians. The study of the history of medicine, thus, encourages them to continue their ancestors' work (Macnaughton, 2000).

The Alcmaeon project focuses on changing the way the history of medicine is taught. It is common knowledge that medicine is related to other fields. Medicine borrowed concepts from other scientific disciplines such as physics and

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chemistry to describe or explain sickness and health. The reverse also stands true. Quite recently 'medical humanities' promoted a growing exchange between the humanities and medicine. On the one hand, the arts have always found medicine an invaluable source of inspiration. On the other hand, the arts have been used in therapy to treat and comfort patients. Nowadays more and more lectures use literature or films to improve students' observation skills, communication skills and empathy with their patients (Scott, 2000; Byars *et al*, 2015).

The project aims at elaborating a **training package on the history of medicine** supported by a virtual medical museum and a **virtual video library with testimonials from role-model doctors**. The ALCMAEON virtual museum will display 'learning objects' created within the partnership with a view to promoting different traditions in European medical history. The learning objects are small units of learning which are interactive, interoperable, reusable, multimedia and easily accessible online. They comprise small digital pieces of content, such as text, audio, video, graphics and animations. They can be compared to Lego blocks, whose small pieces can be used, reused or combined to build many different structures, such as tutorials, case-based learning or simulations (Churchill, 2007; Rouiz *et al*, 2009).

MATERIAL AND METHOD

What follows is the discussion of the findings of the focus group organised at the University of Medicine and Pharmacy Grigore T. Popa for the Alcmaeon Project.

The project application stipulated to use the focus group discussion among specialists in the field as a means to meet the objectives of the baseline research. The focus group discussion is a frequently used method, where a researcher assembles a group of individuals to discuss a specific topic, aiming to draw information from the complex personal experiences, beliefs, perceptions and attitudes of the participants through a moderated interaction. The researcher adopts the peripheral role of a "moderator" facilitating a group discussion between participants. (Nyumba *et al*, 2019). The application recommended this technique for its quality to set up a friendly informal atmosphere which encourages participants to open up and sincerely share their opinions and experiences; thus, it provides authentic insights into participants' perceptions and understanding of the concepts under discussion.

Some elements of the focus group discussion were utilised to meet the project's

research objectives. The method consisted of the four major steps: design, data collection, analysis and reporting of results. The process began by establishing the main purpose of the focus group and defining the key research objectives of the study. The main topic of the discussion focused on participants' previous experience of teaching medical humanities and medical history in order to explore their understanding of the main topic and views as to how to innovate the teaching of medical history in medical education.

The discussion aimed at the following objectives: identifying participants' perceptions about the issue in order to demonstrate that medical history is part of evidence-based medical practice; eliciting the main techniques in teaching the history of medicine and medical humanities; establishing the role and impact of the history of medicine and medical humanities on students' medical training.

Based upon the research objectives, a list of questions was prepared as guidance for the focus group discussion.

The project's application also set a few ground rules for the organisation of the focus group (everyone's views were important so everyone was invited to share; there were no right or wrong answers, so a range of views was welcome; consensus was not required).

Thereafter, participant identification and recruitment was an essential step since the technique is largely based on group dynamics and relationships among participants (Rabiee, 2004; Nili *et al*, 2017). The group consisted of 14 professionals (as recommended by the application): historical and legal medicine lecturers, medical education researchers, medical history researchers and medical language learning lecturers.

The focus group was conducted by a moderator and there was a person supporting the registration of the results. The application stipulated that there was no need for a transcription of the focus group: its main conclusions were written down. Once the discussion was completed, for each question the main ideas that occurred in the answers were collected and reviewed to identify ideas which were repeated. Main themes were identified and quotations that illustrated each theme were selected.

RESULTS AND DISCUSSIONS

The discussion developed along two sets of questions. The first set focuses on exploring professionals' understanding of what the main topic is.

No	Question	Answers	Number of answers
1.	What difficulties they met when teaching medical history	a. how to better stimulate students' motivation	5
		b. which are the most suitable techniques for their specific group of students	5
		c. how to deal with groups where most of the students come from diverse educational and cultural background	4
2	Whether they considered the integration of medical history into the medical humanities course as appropriated and what approach they prefer	the history of medicine helps students	14
		a. an approach that raises students' interest	12
		b. the intercultural learning method	4
		c. use of arts (literature, film, painting)	10
		d. efficient communication (interactive strategies that lead to the co-creation of knowledge, positioning, sharing of opinions)	10
		e. interdisciplinary approach: medicine subcategories, bioethics, medical humanities, legal medicine, arts	14
		f. highly enhanced technology teaching	14
3	What kind of curriculum they consider more appropriated to the teaching of medical history and why	a. a course focusing on the process of medical development over time, giving insights into past procedures and achievements	14
		b. course whose content and delivery mode is in tune with students' knowledge and experience	14

Most participants held that stimulating students' motivation and finding the most suitable techniques to reach them are essential when it comes to raising students' interest. Some of them were of the opinion that "highly enhanced technology teaching" and "a holistic and integrated approach of medicine" could be the solution. Participants were in favour of "interactive strategies that lead to the co-creation of knowledge, sharing of opinions and also an understanding of the legislative component". However, no matter what techniques are used, be they non-formal (role-playing, simulation, case studies, interviews, reflection) or digital formulas all methods should consider "the human factor, take students' perspective and encourage their experimenting with independent thought". A combination of a wide variety of methods is the solution.

A respondent stated that she found it difficult to teach students from a multicultural background and spent time trying to aggregate the groups. Participants agreed that cultural differences are a problem if they are not used and valued in

teaching. "I find that an effective solution is to continually encourage the participation of representatives from different countries and then to include these specific contributions in the learning act". The multicultural environment should be used because students can "learn a great deal from each other, when it comes to identity clashes or cultural clashes". Given the multicultural world we live in "the intercultural learning method and that of harmoniously combining and utilizing all competences" is a solution.

As for preferred methods some of them thought that it is necessary to use an approach that raises students' interest; lecturers should use tools and techniques rooted in and adapted to the medical reality: "we do not know what medicine will look like in 2030 when they start working, that is, we do not know what it will look like in five years, when a virtual reality-based medicine will possibly come to the fore"; given the rapidly changing world, students need to be flexible.

There were supporters of the interdisciplinary approach: medicine, legal medicine, arts when students had to combine

information from different areas, all relevant for their case. The interdisciplinary approach is beneficial for the student's interest. Just in the case of the "communication between doctor and patient, one can discuss ethics, the patient's rights, as well as specific personal professional skills such as empathy, teamwork, decision-making".

All participants agreed that the history of medicine helps students and should be integrated into the medical humanities course. All participants agreed that teaching the history of medicine should focus on the process of medical development over time. Its study is necessary as it gives students insights into past procedures and achievements, raises their awareness about the importance of medical and social ethics, gives lessons in medical education, empathy, charity work, community involvement, ethical standards, laboratory research. Successful earlier performance instils a sense of pride in medical achievements, create high expectations and motivate succeeding generations to continue to excel.

Respondents also claimed that courses are far too focused on medical disciplines and less on medical humanities. Students feel the need for diversity, for the human touch in the curriculum. Thus, participants were of the opinion that art,

literature and films can help future doctors improve their observation skills, enhance empathy and cope with moments of uncertainty. Visual observation is at the centre of medical practice: doctors have to perceive contextual details and interpret visual clues from patients. However, students are given few opportunities to develop observation skills during their studies. The observation and interpretive skills involved in visual art or reading literature are relevant to the medical act and therefore, art should be used in medical education to improve students' observational skills, communicative skills, reflection and empathy with their patients. Students learn to understand a situation from different points of view, to empathize with another person's dilemma, to accept different perspectives and ways of thinking and to examine things creatively. Everybody agreed that the mix of art and medicine includes elements the students like and encounter in their spare time (film, literature, entertainment). Moreover, "the harmony between free time- that is so little - and their profession enriches the person".

The second set of questions focuses on exploring experts' views about how to innovate the teaching of medical history in medical education.

No	Questions	Answers	Number of answers
1	What do you think about e-learning as support to teach medical history?	It "encourages the student to learn more".	10
		It offers a positive experience	12
2	What do you think about the support of a digital museum which will help students to learn and perform research in medical history?	It will be useful to both lecturers and students;	14
		It will create useful resources which could be combined or granulated according to need;	14
		It will offer role models for doctors;	14
		It will provide medical cases	14
3	What do you think about the use of object-based learning in medical history?	It will offer ideas and resources to lecturers and encourage and motivate students to study	14

All experts were in favour of digital media that "encourages the student to learn more". However, the respondents plead for "an approach to technology which starts from the simple realisation that medicine is and should be a discipline of the humanities". The respondents' teaching experience with integrating digital platforms or mobile apps has only been positive. They are confident that "the future of learning is entirely digital and that the younger generation of teachers will have a more relaxed approach to

technology, incorporating it effortlessly into their courses. What I see in the future is a curious student, who will do research on their own, and will use the time together to clarify and debate aspects of what they have learnt on their own".

Digital museums would provide lecturers and students with useful resources: videos with doctors sharing their knowledge and experiences or cases. "These doctors can be valuable role models for the students and I have used them successfully in class. This shows their clear need for role

models, which mass-media simply cannot provide them with. Such an archive would be an invaluable tool which we can use in all our classes with a great impact on students. Also, videos of real medical cases, doctor-patient interactions and real-life examples of ethical questions or global medicine would be of great help”.

Respondents defined Learning Objects as any entity, digital or non-digital, which may be used for learning, education or training”. Each learning object can be used independently, in multiple contexts for multiple purposes. They can be aggregated into larger groups. Their descriptive information allows them to be easily found and accessed. Each learning object meets a learning objective. Respondents appreciated Learning objects as useful learning elements offering medical educators a way to make education more efficient and encouraging students to study. They can be accessed by many computers and used by several learners at any time. They consist of small chunks of content: reusable electronic text and multimedia resources that support and enhance learning. Educators are no longer content presenters but become facilitators of the students’ learning and evaluators of their competence.

CONCLUSIONS

The training package has been tailored to meet the respondents’ suggestions. Thus, it aims to help students:

- develop a general medical humanist cultural background.
- explain contemporary medicine in terms of its historical development and internalize epistemological values and ethical medical principles.
- develop investigation, analysis and interpreting abilities for certain complex themes and issues related to the history of medicine.

The training package is meant to raise students’ awareness about the necessity to study the history of medicine, which is a formative component of medical studies. The student will be able to comprehend and utilize the means through which the historical text recuperates the medical past.

The partnership selected the main topics of the syllabus: Prehistoric medicine, Hippocratic medicine, Arabic medicine, Renaissance medicine, Modern medicine, Contemporary medicine.

The Romanian team develops the Contemporary Medicine unit. The main strands of the units follow four thematic areas: clinical practice (evidence-based medicine), medical ethics (health expectations and experiences in terms of

values and ethical principles change over time), medical social sciences (lifestyle, environment, global health) and communication skills (doctor-patient relationship). For each unit partners will produce a case scenario supported by a video used as an introduction to the unit.

In accordance with respondents’ suggestions teaching methods will make use of highly enriched technology. In addition, arts can be used as a means to educate students through interpretation and discussion about their observations in a pleasant atmosphere. Including the arts and humanities in studying medicine help students develop professionalism, self-awareness, and communication skills that are increasingly important for physicians. Bringing these subjects together may enable students form deeper connections with patients and develop empathy and creativity.

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FAST FOOD CONSUMPTION OF STUDENTS AND FACTORS AFFECTING CONSUMPTION: A CASE STUDY FROM ISPARTA UNIVERSITY OF APPLIED SCIENCES, TURKEY

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Abstract

In this study, it was aimed to determine fast food consumption and the factors affecting this consumption for Isparta University of Applied Sciences students. The main material of the study consisted of the data obtained from surveys, which were conducted by face-to-face interviews with 384 students. Result showed that 89.06% of the students consumed fast food and 10.94% did not. The average monthly income of students was 1412.26 TL and the share of expenditure on fast food products in the monthly income was 21.25%. It was determined that students consumed steak tartar ala turca (85.96%) among the fast food products, followed by French fries (83.63%) and hamburger (82.75%). It was found that 42.69% of the students consumed fast food products in dinner. It was determined that the most important reasons for fast food consumption were being economical (38.60%) and fast (30.70%). The relationship between the age of the students ($p < 0.10$), the number of individuals in the family ($p < 0.10$) and their opinion about healthy-eating ($p < 0.01$) and fast food consumption were found to be statistically significant.

Key words: Fast food, consumption, preferences, students

Fast food is a food system which serves maximum number of consumers in the minimum amount of time for which foods that are prepared with standard methods are produced and sold. The concept of fast food that is used for foods that are prepared in very short amounts of time first emerged in the USA as worker cafeterias, food and beverage wagons on the street and food stands (Anıl M., et al. 2011). The food and drink habits of people changed rapidly especially with the production of hamburger and hot-dog products and this market that encompasses these products has transformed into a billion-dollar industry in our day (Zhong C.B and DeVoe S.E., 2010).

Catering sector is classified into four main groups as; hotels, restaurants, fast food restaurants and table d'hôte (corporate food services). Another name used for this sector is out-of-home food sector. The annual turnover for the catering sector in Turkey is 24.7 billion dollars based on 2015 data. The percentages have been divided as follows: restaurants with 35 %, table d'hôte with 30 %, hotels with 20 % and fast food restaurants with 15 %. The share of the fast food sector is increasing rapidly parallel to the economic growth and socio-cultural changes (TAVAK, 2018).

The sector that actually has quite a long history in Turkey with foods that can be prepared

in a very short amount of time such as börek, Turkish pide, pizza with spicy filling, döner kebab, etc. got introduced to the concept of fast food when McDonald's entered the market in 1986 after which it gained its current activity growing rapidly. Even though majority of the local and foreign companies active in the sector are located in large cities such as İstanbul, Ankara and İzmir; today they can be found all over Turkey. The factors that are effective in the improvement of the fast-food sector can be listed as; increase in urbanization rate, participation of women in work life, increase in family income levels, establishment of the habit of eating out, limited amount of time spared for eating due to the increasing tempo of work life, increase in young population and the impact of advertisements (Kılıçaslan R., 2019).

Changing economic, social and cultural ways of living result in changes in the eating habits of individuals as well. Busy work life and the increasing participation of women in professional life decreases the amount of time spared for eating thereby directing family members more and more to consuming fast food. The fast food consumption habits of young people who make up a significant portion of the market are increasingly becoming a topic of interest for marketing researchers and implementers (Uğur U., 2018). The purpose of the

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present study was to analyze the fast food consumption of students at the Isparta Applied Sciences University as well as the related factors. It is hoped that the results obtained in the study will be beneficial for the consumers, fast food sector and researchers who will work on this subject.

MATERIAL AND METHOD

The main material of the study was comprised of face-to-face interviews conducted with Isparta Applied Sciences University Undergraduate students. In addition, results of previous studies on this topic were also used. Interviews with the students were conducted during the October-November 2018 period.

The “unclustered sampling method” specified by equation 1 was used for determining the number of students to be interviewed (Collins M., 1986).

$$N = t^2(p*q) / e^2 \quad (1)$$

Here; t: t-table value corresponding to the 95 % significance level (1.96), p: probability for that event to take place (0.50) (the ratio of fast food consuming students in this study), q: probability for the case that the event will not take place (0.50) and e: margin of error accepted for sampling (5 %). It was determined as a result of the calculation made via Equation 1 that the sample number is 384. The acquired data were analyzed via MS Excel and SPSS software after which related tables were generated and these tables were interpreted by way of absolute and relative distributions and simple and weighted averages methods.

The relations between the demographic characteristics of the students and fast food consumption were analyzed via Chi-square (χ^2) test. The Chi-square test is one of the most frequently used tests among the non-parametric tests. Chi-square (χ^2) independence test aims to test the similarities between the frequencies observed in crosstabs of a x b type (G_{ij}) with the calculated theoretical frequencies (T_{ij}) (Bircan H., et al. 2003). Chi-square (χ^2) test statistics was solved using the following notation (Çömlekçi N., 2001);

$$\chi^2 = \sum (G_{ij} - T_{ij})^2 / T_{ij}$$

RESULTS AND DISCUSSIONS

The demographic characteristics of the students are presented in *Table 1*. It was determined that 66.93 % of the interviewed

students were male and that 33.07 % were female. Majority of the students (53.90 %) were determined to be in the 21-23 age group. It was calculated that 40.10 % of the students are continuing their educations at the Faculty of Agricultural Sciences and Technologies, 26.04 % at the Faculty of Technology, 21.09 % at the Faculty of Forestry and 12.77 % at the Fisheries Faculty. Currently, education is ongoing at the aforementioned four faculties of the Isparta Applied Sciences University. It was determined that the monthly income levels of the students vary between 501-1000 TL (42.45 %) and 1001-2000 TL (37.76 %) and that the ratios of students with income levels of less than 501 TL (11.72 %) and more than 2000 TL are lower. It was determined upon examining the accommodation status of the students that; students mostly stay at student houses (39.06 %) followed by apartments for rent (29.69 %).

Table 1

Demographic characteristics of students

Demographic characteristics		n	%
Gender	Male	257	66.93
	Female	127	33.07
Age (year)	18-20	79	20.58
	21-23	207	53.90
	>23	98	25.52
Education	Agricultural Sciences and Technologies Faculty	154	40.10
	Technology Faculty	100	26.04
	Forestry Faculty	81	21.09
	Eğirdir Fisheries Faculty	49	12.77
Income (TL/month)	<501	45	11.72
	501-1000	163	42.45
	1001-2000	145	37.76
	>2000	31	8.07
Accommodation	Student house	150	39.06
	Apartment for rent	114	29.69
	Government dormitory	56	14.58
	With family	52	13.54
	Private dormitory	10	2.60
	With relatives	2	0.52
Place where the student grows	Provincial center	228	59.38
	County center	111	28.91
	Village-town	45	11.72
Do you work?	Yes	66	17.19
	No	318	82.81
Average number of people in the family (person)		3.64	

The ratio of students residing at government dormitories was determined as 14.58 % while the ratio of students living with relatives was determined as 13.54 %. It was determined when the residence locations of the students were

examined that majority has grown up in provincial centers (59.38 %). The ratios of students that grew up in county centers and villages-towns were calculated as 28.91 % and 11.72 % respectively. It was determined that 82.81 % do not work at any job and that 17.19 % are employed. The average number of people in the families of students was determined as 3.64.

Table 2 presents the education levels of the parents. It can be observed when the education levels of the parents are examined that in general the education levels are quite low. Indeed, it was determined that the ratio of primary school graduate mothers is 42.19 % and that the ratio of primary school graduate fathers is 30.47 %. The ratio of university graduate mothers was determined to be very low (10.42 %). The ratio of university graduate fathers was determined to be higher than that of mothers (25.00 %).

Table 2

Education level of mother and father

Education level	Mother		Father	
	n	%	n	%
Primary school	162	42.19	117	30.47
Middle school	98	25.52	69	17.97
High school	84	21.87	102	26.56
University	40	10.42	96	25.00
Total	384	100.00	384	100.00

The occupations of the parents of the students are given in Table 3. Accordingly, it was determined that majority of the mothers are housewives (69.79 %). Whereas it was determined that fathers are mostly employed and the ratio of unemployed fathers was quite low (1.30 %). It was observed when the occupations of the fathers are examined that retired fathers are ranked number one (27.60 %) followed by employees (19.79 %), officers (19.53 %), shopkeepers (18.76 %) and self-employment (13.02 %).

Table 3

Occupation of mother and father

Occupation	Mother		Father	
	n	%	n	%
Officer	36	9.38	75	19.53
Employee	30	7.81	76	19.79
Shopkeeper	11	2.86	72	18.76
Retired	24	6.25	106	27.60
Self-employment	15	3.91	50	13.02
Housewife	268	69.79	-	-
Unemployed	-	-	5	1.30
Total	384	100.00	384	100.00

Tables 4 and 5 present the fast food consumption status of the students and the types of fast foods they consume. It was determined that 89.06 % of the students consume fast food and that 10.94 % do not. The highest ranked fast foods consumed were determined in order as steak tartar ala turca (85.96 %), French fries (83.63 %), hamburger (82.75%), toast (81.87%), a pizza with spicy filling (80.99%), Turkish pide (80.70%), pizza (78.95%), döner kebab (77.78%) and chicken tenders (70.76%). Sayılı and Gözener (2013) carried out a study in which it was determined that 71.38 % of the students consume fast food whereas it was determined as a result of the study by Özçiçek *et al.*, (2002) that 88.43 % of the students consume fast food. Kınır *et al.*, (2015) determined in a study that 25.7 % of the students prefer eating hamburger, 5 % prefer kumpir, 26.7 % prefer steak tartar ala turca, 40.3 % prefer döner kebab, 44.6 % prefer pizza with spicy filling and 15.3 % prefer pizza. Yardımcı *et al.*, (2012) carried out a study as a result of which it was put forth that pizza, döner kebab and hamburger are among the most frequently consumed fast foods.

Table 4

Fast food consumption status of students

Do you consume fast food?	n	%
Yes	342	89.06
No	42	10.94
Total	384	100.00

Table 5

Types of fast food consumed

Types of fast food	n	%*
Steak tartar ala turca	294	85.96
French fries	286	83.63
Hamburger	283	82.75
Pizza	270	78.95
Chicken tenders	242	70.76
A pizza with spicy meat filling	277	80.99
Turkish pide	276	80.70
Baked potato	184	53.80
Tantuni	205	59.94
Sandwich	223	65.20
Toast	280	81.87
Döner kebab	266	77.78
Grilled sheep's intestines	212	61.99
Meatball sandwich	251	73.39

Table 6 shows the frequency of fast food consumption among students. It was observed that

students eat hamburger at most once a month (27.56 %), once every two months (25.09 %) and 1-2 times per week (21.55 %), that they eat pizza once a month (31.48 %), once every three months (23.33 %) and once every two weeks (18.52 %), chicken tenders once a month (25.21 %), once every two weeks (20.25 %) and 1-2 times per week (17.36 %), steak tartar ala turca once a month (27.21 %), once every two weeks (23.81 %) and 1-

2 times per week (21.77 %), pizza with spicy filling once a month (35.02 %) once every two weeks (21.30 %), Turkish pide once a month (34.06 %) and once every two weeks (22.10 %), toast 1-2 times per week (36.79 %), 3-4 times per week (19.64 %) and once every two weeks (18.21 %), döner kebab 1-2 times per week (36.47 %), once every two weeks (19.55 %) and 3-4 times per week (18.05 %).

Table 6

Frequency of fast food consumption

Types of fast food	Frequency of consumption							
		Everyday	1-2 a week	3-4 a week	Once two weeks	Once in a month	Bimonthly	Quarterly
Hamburger	person	3	61	20	71	78	23	27
	%	1.06	21.55	7.07	25.09	27.56	8.13	9.54
Pizza	person	1	24	7	50	85	40	63
	%	0.37	8.89	2.59	18.52	31.48	14.81	23.33
Chicken tenders	person	5	42	19	49	61	26	40
	%	2.07	17.36	7.85	20.25	25.21	10.74	16.53
Steak tartar ala turca	person	6	64	28	70	80	19	27
	%	2.04	21.77	9.52	23.81	27.21	6.46	9.18
A pizza with spicy meat filling	person	2	28	14	59	97	40	37
	%	0.72	10.11	5.05	21.30	35.02	14.44	13.36
Turkish pide	person	2	44	21	61	94	27	27
	%	0.72	15.94	7.61	22.10	34.06	9.78	9.78
Kumpir	person	1	7	5	15	37	36	83
	%	0.54	3.80	2.72	8.15	20.11	19.57	45.11
Tantuni	person	2	17	9	29	46	33	69
	%	0.98	8.29	4.39	14.15	22.44	16.10	33.66
Sandwich	person	15	41	32	35	43	14	43
	%	6.73	18.39	14.35	15.70	19.28	6.28	19.28
Toast	person	27	103	55	51	21	9	14
	%	9.64	36.79	19.64	18.21	7.50	3.21	5.00
Döner kebab	person	17	97	48	52	27	12	13
	%	6.39	36.47	18.05	19.55	10.15	4.51	4.89
Grilled sheep's intestines	person	6	20	17	44	45	19	61
	%	2.83	9.43	8.02	20.75	21.23	8.96	28.77
Meatball sandwich	person	4	53	28	59	66	21	20
	%	1.59	21.12	11.16	23.51	26.29	8.37	7.97
French fries	person	26	114	56	44	26	10	10
	%	9.09	39.86	19.58	15.38	9.09	3.50	3.50

Acar (2016) carried out a study in which it was reported that the number of individuals who consume French fries more than once every day is quite high, that the number of people who consume döner kebab, dürüm, burger products daily has increased intensively and that foods such as chicken tenders, steak tartar ala turca, kumpir,

sandwich, grilled sheep's intestines are not consumed by some of the participants.

Table 7 shows the fast food consumption meals. As can be seen from the table, it has been determined that students consume fast food mostly during dinner (42.69 %) followed respectively by breakfast (26.32 %) and lunch meals. Acar (2016) carried out a study in which it was determined that

students mostly consume fast food products during lunch (34.00 %) and afternoon (46.8 %) meals.

Table 7

Fast food consumption meals

Meals	n	%
Breakfast	90	26.32
Lunch	76	22.22
Dinner	146	42.69
Late night	30	8.77
Total	342	100.00

Table 8 indicates the reasons for fast food consumption of students. As can be seen from the table, students have mostly indicated that they prefer consuming fast food because it is economic (38.60 %) and fast (30.70 %). Sayılı and Gözener (2013) carried out a study in which it was the reasons put forth by students for consuming fast food were determined as; more practical (61.32 %), palate (36.79 %), not liking the menu (15.09 %), not knowing how to cook (13.21 %) and cheaper (12.74 %). Korkmaz (2005) carried out a study as a result of which it was put forth that hygiene, healthy products, quality, filling and price were indicated as the most important factors respectively which influence the decisions of students to purchase fast food products.

Table 8

Reasons for fast food consumption

Consumption reasons	n	%
Economic	132	38.60
Fast	105	30.70
Taste	49	14.33
I like	45	13.16
Satisfying	7	2.05
Hygiene	2	0.58
Healthy	1	0.29
Popular	1	0.29
Total	342	100.00

Table 9 presents the reasons not to consume fast food. Accordingly, majority of the students indicated that it is not healthy (50.00 %) and that they do not like it (38.10 %). The ratio of those who do not consume fast food because it is expensive was determined to be lower (11.90 %). Sayılı and Gözener (2013) carried out a study in which it was put forth that students do not consume fast food because they do not have such a habit (54.12 %) and because it is not healthy and hygienic (42.35 %).

Table 9

Reasons not to consume fast food

Reasons not to consume	n	%
I don't like	16	38.10
Expensive	5	11.90
It is not healthy	21	50.00
Total	42	100.00

Table 10 shows the fast food expenditures and their share in monthly income. The monthly income levels of the students vary between 398.89 TL and 1412.26 TL with the group average calculated as 1412.26. The monthly fast food expenditures of students increase with increasing income groups. Monthly fast food expenditures were determined as 182.67, 186.32, 202.69 and 153.87 TL respectively for groups of <501, 501-1000, 1001-2000 and >2000. Average of all groups was determined as 181.39 TL. It was determined that the shares of fast food expenditures in total income decrease with increasing income levels. Indeed, the share of fast food expenditures in monthly income was determined as 45.79 % for the group with the lowest income, whereas it was calculated as 5.47 % for the group with the highest income. The fast food expenditure share according to the average of all groups was determined as 21.25 %.

Table 10

Fast food expenditures

Income groups (TL)	Income (TL/month)	Fast food expenditures (TL/month)	Share of fast food expenditure (%)
<501	398.89	182.67	45.79
501-1000	911.13	186.32	20.45
1001-2000	1527.72	202.69	13.27
>2000	2811.29	153.87	5.47
Average	1412.26	181.39	21.25

When the opinions of students on healthy nutrition were asked, 64.58 % of the students indicated that they are not eating healthy food while 35.42 % were of the opinion that they are eating healthy food (Table 11).

Table 11

Students' opinion about healthy nutrition

Do you think you are eating healthy?	n	%
Yes	136	35.42
No	248	64.58
Total	384	100

The relationships between the fast food consumption of students and their demographic characteristics were analyzed via Chi Square and the results are presented in Table 12. Accordingly, the relationships between the students age,

($p < 0.10$), number of people in the family ($p < 0.10$) and opinions about healthy nutrition ($p < 0.01$) and fast food consumption were determined to be statistically significant. The relationships between the gender, accommodation, monthly income, place where the student grew up and state of employment with fast food consumption were not determined to be statistically significant. Akbay *et al.*, (2007) carried out a study as a result of which it was put forth that factors such as age, income, education, household size, children and consumer attitude towards fast food price, health issues and child preference have significant impacts on fast food consumption.

Table 12

The relationship between fast food consumption and demographic characteristics

Variables	Pearson χ^2	Degree of freedom	P
Gender	0.149	1	0.700
Age	4.725	2	0.094*
Accommodation	0.472	7	1.000
Income (TL/month)	2.249	3	0.522
Place where the student grows	3.819	3	0.282
Number of people in the family	13.822	8	0.087*
Working in a job	0.925	1	0.336
Opinion about healthy nutrition	57.213	1	0.000***

CONCLUSIONS

It was determined that 66.93 % of the students who participated in the questionnaire were male and 33.07 % were female with majority (53.90 %) in the 21-23 age group, residing in student houses (39.06 %), having monthly average incomes of 1412.26 TL and that they have generally been raised in provincial centers (59.38 %). It was observed that 89.06 % of the students consume fast food with monthly fast food expenditures of 181.39 TL and with fast food expenditures share in monthly incomes of 21.25 %. Steak tartar ala turca, French fries, hamburger, toast, pizza with spicy filling, Turkish pide, pizza, döner kebab and chicken tenders were determined to be the most frequently consumed fast foods. It was determined that students prefer fast foods mostly during dinner and because it is economic and fast. Students who do not consume fast food indicated their reasons for not consuming fast food as that it is not healthy (50.00 %) and that they do not like it (38.10 %). A statistically significant relationship was determined between the age of the students ($p < 0.10$), number of people in the family ($p < 0.10$) and opinions on healthy nutrition

($p < 0.01$) with fast food consumption. A statistically significant relationship could not be determined between gender, accommodation, monthly income, place where the student grew up and status of employment with fast food consumption. Findings obtained in this and similar studies will help the fast food sector understand consumer behaviors related with fast food consumption and thus make improvements accordingly.

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FUNCTIONAL MODEL FOR DETERMINING THE OPTIMAL DURATION OF USE OF FIXED ASSETS

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Abstract

The purpose of this paper was to present a functional model for determining the duration of use of fixed assets based on the relationship between the average fixed cost of depreciation of the fixed medium and the opportunity cost determined by the market of the respective product. The objectives of the paper included: 1. determining the correlation between the duration of use, the total distance travelled and the price of fixed assets; 2. determining the optimal duration of use of the fixed assets based on the relationship between the average fixed cost and the opportunity cost. In order to determine the optimal duration of use, the minimum marginal cost of depreciation was calculated as the ratio of the difference between the prices between moments n and $n + 1$ and the length or kilometres travelled in the range n and $n + 1$. Also, the marginal opportunity cost for the remaining transport capacity to be used was determined starting from the hypothesis that the market assigns a price to a usable capacity and to a capacity too old to be used, the price is nil. As a result, we identified the average price for the maximum duration or distance of use. The marginal opportunity cost was determined as the ratio between the price at one point and the remaining difference to be used by kilometres or old. The remaining difference to be used was calculated as the difference between the maximum duration that can be used and the time at time i or the maximum distance travelled and the distance travelled at price i . The average cost with the depreciation of the fixed means analysed is determined by the distance travelled and its age. The proposed model allows to determine an optimal duration of use of the fixed means according to their age and the transport distance. This model can be easily adapted to other types of fixed assets and the quality of the results is given by the existence of a significant number of data on their selling prices.

Key words: optimum use, investments, opportunity cost

Increasing the lifespan of fixed assets is a particularly current challenge, especially in the conditions of accelerated environmental degradation (Krezo S. *et al*, 2016; Tscheikner-Gratl F. *et al*, 2015; Twerefou DK. *et al*, 2015). In contrast, this desire may lead to higher costs for companies due to increased repair costs (Guiraud P, Moulinier F., 2008; Robati M., McCarthy TJ., 2018). As a result, scientific research seeks solutions to maximize the life span of fixed assets while increasing the economic performance of companies (Budde M., Minner S., 2015; Yard S., 2000; Pascual R. *et al*, 2016)

MATERIAL AND METHOD

The purpose of this paper was to present a functional model for determining the duration of use of fixed assets based on the relationship between the average fixed cost of depreciation of the fixed medium and the opportunity cost determined by the market of the respective product.

The objectives of the paper included: 1. determining the correlation between the duration of use, the total distance travelled and the price of fixed assets; 2. determining the optimal duration of use of the fixed assets based on the relationship between the average fixed cost and the opportunity cost.

In order to determine the optimal duration of use, the minimum marginal cost of depreciation was calculated as the ratio of the difference between the prices (P) between the moments n and $n + 1$ and the seniority (D) or kilometres (P) travelled in the interval n and $n + 1$ after calculation relation:

$$C_m = (P_n - P_{n+1}) / (D_n - D_{n+1}) \text{ or}$$

$$C_m = (P_n - P_{n+1}) / (R_n - R_{n+1}).$$

Also, the marginal opportunity cost for the remaining transport capacity to be used was determined. This process started from the hypothesis that the market assigns value (price) to a usable capacity and to a capacity too old to be used, the price is null. As a result, we identified the average price for the maximum duration or distance of use.

The marginal opportunity cost was determined as the ratio between the price at one point (P_i) and the remaining difference to be used by kilometres or by age. The remaining difference to be used was

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calculated as the difference between the maximum usable duration (D_{max}) and the time at time i (D_i) or the maximum distance travelled (R_{max}) and the distance travelled at price i (R_i) after the calculation relation:

$$C_o = P_i / (D_{max} - D_i) \text{ or}$$

$$C_o = P_i / (R_{max} - R_i).$$

The research methodology consists of conducting a case study within an economic unit active in agriculture. The information used was obtained from the commercial databases, online AUTOVIT.RO (www.autovit.ro., 2019), AutoScout24.ro (www.autoscout24.ro, 2019) and MOBILE.DE (www.mobile.de, 2019). From these were extracted data on a means of transport freight - utility vehicle with a specific brand (which will not be specified in order not to cause image damage), 136 HP, payload: 2,801 - 3.5 t. including prices according to the length and number of kilometres travelled until the announcement was posted.

Data processing was performed in Microsoft Office and SPSS with the Pearson correlation coefficient, the regression coefficient and the ANOVA matrix determined.

RESULTS AND DISCUSSIONS

The determination of the correlation between the duration of use, the total distance travelled and the price of the fixed means indicated a Pearson coefficient of -0.673, which suggests a reduction of the price according to the increase of the distance travelled by the means of transport for which the research is carried out.

Table 1
The correlation between the number of km travelled and the price

		No. Km	Price (euro)
No. Km	Pearson Correlation	1	-.673**
	Sig. (2-tailed)		.000
	N	178	178
Price (euro)	Pearson Correlation	-.673**	1
	Sig. (2-tailed)	.000	
	N	178	178

** . Correlation is significant at the 0.01 level (2-tailed).

The correlation between the number of km travelled and the price is statistically ensured for an error of 1% for a sample of 178 values.

Table 2
The correlation between age and price

		Price (euro)	Years old
Price (euro)	Pearson Correlation	1	-.846**
	Sig. (2-tailed)		.000
	N	178	178
Years old	Pearson Correlation	-.846**	1
	Sig. (2-tailed)	.000	
	N	178	178

** . Correlation is significant at the 0.01 level (2-tailed).

The correlation between age and price (tab. 2) records Pearson coefficient values of -0.846 for the same error, showing that the price decreases depending on the length of use.

Table 3

The correlation between the value of the depreciation and the price

		Depreciation (euro/km)	Price (euro)
Depreciation (euro/km)	Pearson Correlation	1	.713**
	Sig. (2-tailed)		.000
	N	178	178
Price (euro)	Pearson Correlation	.713**	1
	Sig. (2-tailed)	.000	
	N	178	178

** . Correlation is significant at the 0.01 level (2-tailed).

The correlation between the value of the depreciation and the price (table 3) is positive and has a value of the Pearson coefficient of 0.713, statistically assured for the same error of 1%. These values confirm the hypothesis that the depreciation is determined by the distance travelled by the means of transport and its age.

Therefore, the regression relation between the values of the average depreciation with the useful life and the number of kilometres travelled has been determined.

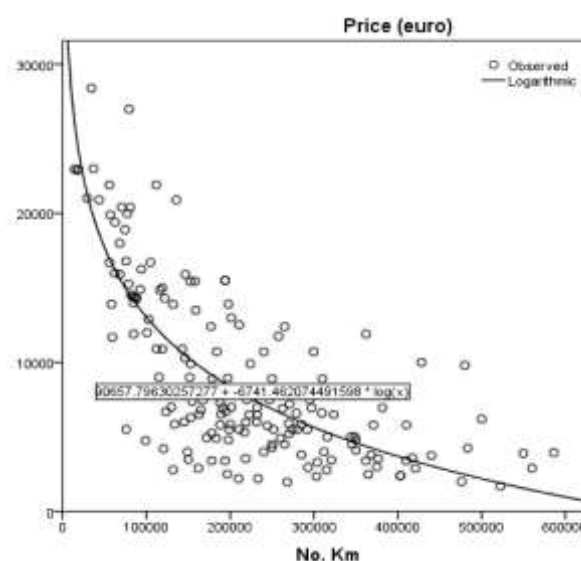


Figure 1 The regression relation between the total distance travelled and the price

The regression relation between the total distance travelled and the price (fig. 1) indicates that by using the depreciation determined cost decreases logarithmically with the distance travelled. Model Summary: $R = 0.786$, $R^2 = 0.617$, Adjusted $R^2 = 0.615$, Std. Error of the Estimate = 3624.796, ANOVA: Sum of Squares = 3726125750, $df = 1$, Mean Square = 3726125750, $F = 283.59$, $Sig. = 0.000$. The independent variable is No. Km.

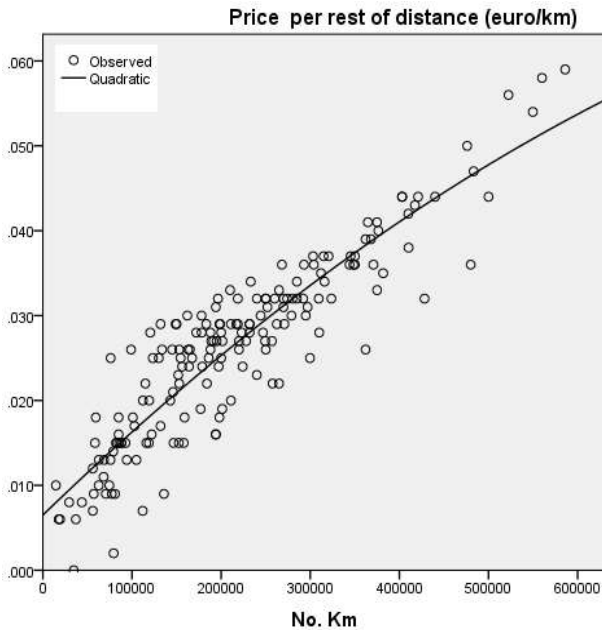


Figure 2 The regression relation between the total distance travelled and the price for the remaining distance for use

The regression relation between the total distance travelled and the price for the remaining distance for use (fig. 2) indicates that through use the cost determined by depreciation increases quadratically with the reduction of the remaining distance for use. Model Summary: $R = 0.91$, $R^2 = 0.828$, Adjusted $R^2 = 0.826$, Std. Error of the Estimate = 0.005. ANOVA: Sum of Squares = 0.017, $df = 2$, Mean Square = 0.009, $F = 422.022$, $Sig. = 0.000$. The independent variable is No. Km.

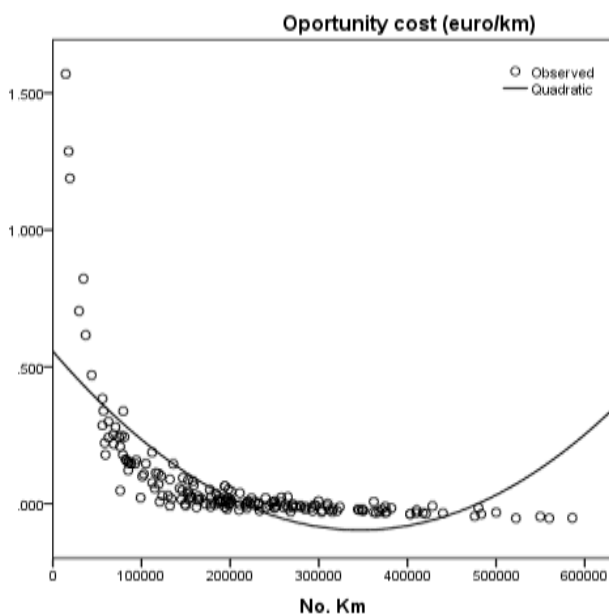


Figure 3 The regression relation between the total distance travelled and the price

The regression relation between the total distance travelled and the price (fig. 3) has a

quadratic shape indicating a minimum cost: 0.007 euros / km at approx. 348,000 km. Model Summary: $R = 0.734$, $R^2 = 0.538$, Adjusted $R^2 = 0.533$, Std. Error of the Estimate = 0.144. ANOVA: Sum of Squares = 4.25, $df = 2$, Mean Square = 2.125, $F = 102.038$, $Sig. = 0.000$. The independent variable is No. Km.

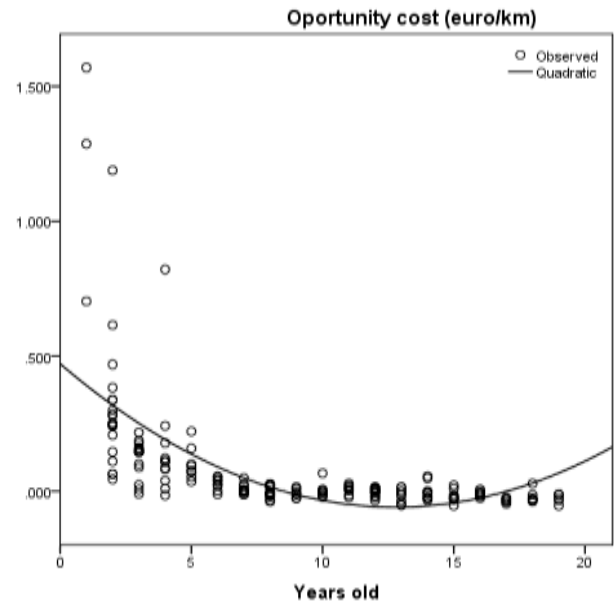


Figure 4 The regression relation between the age of the fixed medium and the price

The regression relation between the age of the fixed medium and the price (fig. 4) has a quadratic shape. Model Summary: $R = 0.639$, $R^2 = 0.409$, Adjusted $R^2 = 0.402$, Std. Error of the Estimate = 0.163. ANOVA: Sum of Squares = 3.228, $df = 2$, Mean Square = 1.614, $F = 60.517$, $Sig. = .000$. The independent variable is Years old. This indicates a minimum cost with depreciation of 0.007 euros / km at 12.4 years.

The proposed model allows to determine an optimum duration of use of the fixed means according to their age and / or the transport distance.

It can be easily adapted to other types of fixed assets and the quality of the results is given by the existence of a significant number of data regarding their prices.

The shortcomings of this research consist in the fact that all the calculations were made based on the information on the prices of the car offer. The existence of sufficient information about the sale price would ensure an additional level of rigor in this approach.

We specify that these results will be different from those that would be obtained by optimizing the internal costs of the users in which the costs of repairs are included (for example) but

this model can provide benchmarks in order to make the opportunity decisions.

By using this model, the users of fixed assets can significantly reduce the operating costs and most likely the social and environmental costs.

CONCLUSIONS

The average cost with the depreciation of the fixed means analysed is determined by the distance travelled and its length.

The proposed model allows to determine an optimal duration of use of the fixed means according to their age and the transport distance.

This model can be easily adapted to other types of fixed assets and the quality of the results is given by the existence of a significant number of data regarding their prices.

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TOURISTS' MOTIVATIONS AND PREFERENCES FOR AGRITOURISM ACTIVITIES

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Abstract

The agritourism is a category of tourism in full expansion worldwide. By its social and economic contribution to the development of rural communities and farms, the agritourism became an attractive alternative for the diversification of agricultural businesses. The main aim of the present paper is to identify, based on the international literature of concern, which are the reasons that determine the tourists to choose agritourism as a form of leisure. The studies carried out by specialists in different countries point out that the tourists' preference for agritourism is highly influenced by the context in which they are, and is generated by a wide range of "push" and "pull" type of factors. The tourists have different expectations from a stay at the agritourism farm due to a large variety of motivations. According to their nature, the reasons to practice agritourism are physical, emotional, cultural and personal, being subject to status or desire for self-development. The physical and mental relaxation, the opportunity to spend nice time together with the family or friends, the possibility to buy fresh fruits and vegetables and the wish to have direct contact with nature and to enjoy the beauty of landscapes are the most obvious motives that determine the tourists to attempt an agritourism experience. The participation at agricultural activities does not represented a major interest for agritourists. The relationships between the tourists' preferences for agritourism activities and their motivations show that they are interested in those activities that are consistent with the initial reasons sustaining their decision to practice agritourism.

Key words: agritourism, tourist motivations, activity preferences

An issue on which the specialists in agritourism field had reached an overall consensus is the fact that the succes of any form of tourism involves the obtaining of satisfaction on behalf of the consumers of tourism products. In order to achieve the tourist satisfaction, it is necessary to know what motivates the tourists to travel towards a certain tourism destination and to choose a certain form of toursim, as well as what they appreciate the most during the stay and which is their post-travel behaviour regading the future tourism-related intentions (Prokopis C., 2010).

The perception of the tourist destination by visitor and the formation of its expectations regarding it are influenced by the motivation (Correia A. *et al.*, 2007). The motivations to travel involves a range of needs that drive a person to engage in a tourist activity (Park D. and Yoon Y., 2009).

Considered a sub-set or a specific form of rural tourism, and in some cases not clearly differentiated from it, the agritourism can be described as an alternative enterprise that provides activities directly linked with the agrarian environment and with the agricultural products, services and experiences (Matezold J., 2002).

The agritourists are the rural tourists who consume agritourism goods and services, while agritourists' needs involve a set of attributes that they would like to obtain as a result of their consumption or purchase. The preferences of the agritourism consumer refer to the level of his interest in the products, services and facilities offered by an agritourism attraction (Nasers M.S., 2009).

The agritourist expectations from the tourist experience are very divers according to the individual, considering both its tangible and intangible aspects (Prokopis C., 2010), the travel frequency to the agritourism attractions being dependent on residence location, travel distance, gender and race (Carpio C.E. *et al.*, 2008).

Knowing and understanding the way in which the agritourism is considered and the experiences sought by tourists in rural areas will allow to determine some factors that are influencing the agritourism demand, thus contributing to the assessment of development and diversification of the tourism activities offered by farmers (Varmazyari H. *et al.*, 2018).

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MATERIAL AND METHOD

The purpose of the present paper is to highlight the most popular motivations that determine the potential tourists to choose the agritourism as a form of leisure. At the same time, the objective was to identify the services and activities preferred by agritourists, on the basis of which farmers can develop more effective promotion strategies and offer more attractive facilities.

In many countries, the terms agritourism and rural tourism are synonymous, which is why our analysis is more extended, referring to aspects regarding the motivations and preferences of rural tourists in general, not only specifically to agritourists. Based entirely on the review of the specialized literature, this paper attempts to answer two essential questions for the development of rural tourism and agritourism: 1) Why tourists come to visit farms and rural areas? and 2) What would they be willing to spend their money on?

By analyzing the international literature it was found that there are not many studies on tourists' motivations for the consumption of agritourism products and services. In order to obtain the most relevant information, hereby were used the results of studies carried out in several countries on 3 continents (Asia, North America, Europe). With this respect was gathered information about the reasons and preferences of tourists from very different geographical areas, both in terms of socio-economic conditions and stages of agritourism development.

RESULTS AND DISCUSSIONS

The agritourists are very heterogeneous in terms of preferences for agritourism activities and services (Barbieri C., 2014; Molera L. and Albaladejo P.I., 2007), being driven by a very complex and wide panel of motivations (Molera L. and Albaladejo P.I., 2007; Park D. and Yoon Y., 2009), these depending largely on the characteristics of the agritourism attractions (Jolly D. and Reynolds K., 2005; Sotomayor S. *et al.*, 2014). The motivation to practice agritourism is determined by a sophisticated set of socio-economic variables, being subject to various external influences (Moraru R.A. *et al.*, 2016), the tourists having different expectations and motivations on different occasions to visit the tourist destination (Lashley C. and Lincoln G., 2003). Furthermore, the tourists' preference for agritourism is highly influenced by the context in which they are, such as health condition, professional and family situation (single or married, with or without children) (Santeramo F.G. and Barbieri C., 2017).

The research carried out by Tsephe N.P. and Eyono Obono S.D. (2013) allowed, based on the review of specialized literature, the identification of factors that influence the motivation of tourists visiting the rural area, these being divided into 4 categories:

- physical factors („pleasure and relaxation of body and mind”, „memorable and once in a lifetime experiences”, „to seek adventure and pleasure”);
- cultural factors („the need to explore and learn more about nature”);
- interpersonal factors („the need to escape from busy daily life”, „the quest for safety offered by friendly local people”, „the quest for pollution free, peaceful, hassle free environment and beautiful landscapes”, „affordability of rural destinations”);
- factors linked with status and prestige („willingness for intellectual enrichment and to discover new things”).

Consumers' preference for a particular form of tourism is determined by “push” and “pull” factors. Tsephe N.P. and Eyono Obono S.D. (2013) also classified the rural tourism motivation factors into these two types (*table 1*). As the agritourism is a special form of rural tourism, we consider that the same motivational factors also act in the case of agrotourists.

Table 1

Motivation factors for rural tourism
(after Tsephe N.P. and Eyono Obono S.D., 2013)

„Push“ Factors	„Pull“ Factors
Escape	Memorable and life time experience
Pleasure and relaxation	Adventure
Intellectual enrichment	Safety
Learn more about nature	Pollution free, peaceful, hassle free environment, beautiful landscapes
	Affordability

The “push” type motivational factors are closely linked to the individual characteristics of the tourist and implies his desire to satisfy his personal needs (for example: rest and relaxation, escape, adventure, health and fitness, social interaction etc.). The “pull” type motivational factors are focused on the attractiveness of tourist destinations, taking into account the attributes of the destination (such as: beauty of the landscape, climate, recreational opportunities, cultural events etc.) and the types of facilities offered (e.g.: quality of services, accessibility, quality of facilities).

Many of the specialty studies have shown that the most popular “push” factors were „knowledge-seeking”, „relaxation”, and „family togetherness”, while the most common “pull” factors refers to „natural and historic

environments”, „cost”, „facilities”, „safety” and „accessibility” (Park D. and Yoon Y., 2009).

Most studies on the motivation for visiting agritourism attractions have been conducted in the USA. Thus, a study that covered the entire national US territory found that the main reasons for agritourists to visit farms were „enjoying the rural landscape”, „visiting family and friends” and „learning about food production” (Barry J.J. and Hellerstein D., 2004). According to the research carried out by Sotomayor S. *et al.* (2011) in Missouri (USA), the most important motivations reported by agritourists were those related to the activities with the family („do something with their family”) and experiencing nature („view the scenic beauty”, „enjoy the smells and sounds of nature”) (table 2). Regarding their favorite activities, most agritourists have expressed their desire to collect fruits and vegetables by themselves (75,9%), to participate in a festival or other event in the rural area (70,3%) and to have the opportunity to observe wildlife (38,5%).

Table 2

The importance of motivations for visiting farms and the main activities preferred by agritourists
(after Sotomayor S. *et al.*, 2011)

Importance of motivations		Main favorite recreation/leisure activities	
Motivations	Importance*	Activities	% of agritourists
Do something with their family	4.28	Pick-your-own fruit/vegetable	75.9
View the scenic beauty	4.25	Attend a festival or event	70.3
Enjoy the smells and sounds of nature	4.06	Wildlife observation	38.5
Experience new and different things	3.98	Hiking, biking or cross-country	33.9
Learn more about nature	3.98	Fishing	33.6
Have a change from their daily routine	3.90	Other recreational activity	30.9
Get exercise	3.84	Boating, canoeing or sailing	25.8
Give their mind a rest	3.70	Attend a private party	20.9
Experience excitement	3.69	Swimming	19.7
Use their equipment	3.65	Horseback riding	13.7
Recall good times from the past	3.59	Hunting	13.0
Experience solitude	3.57	Drive motorized RVs	9.0
Be with people having similar values	3.49		
Think about their personal values	3.43		
Share their agritourism/ outdoor skills	3.07		

* Based on the five point Likert scale: from 1 (“very unimportant”) to 5 (“very important”).

Following the study undertaken in California (USA) by Jolly D. and Reynolds K. (2005), it was found that the strongest motives underlying the consumers' interest in participating in agritourism were: buying fresh and home-made products, supporting local agricultural producers, interaction with nature and relaxation (*fig. 1*). The experiencing of farm activities was the least requested service among those offered by the agritourism farms in this region.

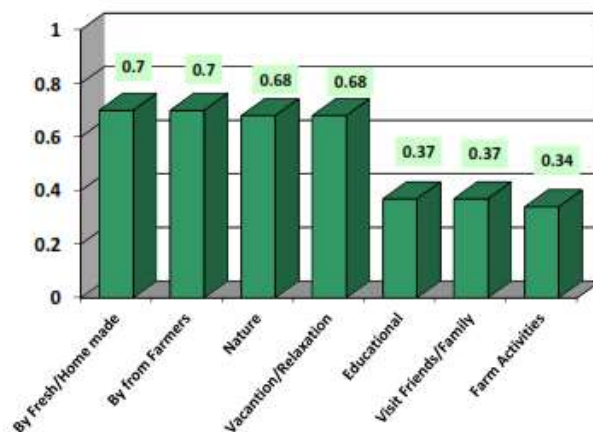


Figure 1 Motivation for participating in agritourism activities (Mean Ranking, scale:0-1)
(Jolly D. and Reynolds K., 2005)

The results obtained in California (USA) by Jolly D. and Reynolds K. (2005) have been largely confirmed by other subsequent studies conducted in different states of the USA. Thus, the opportunity to purchase fresh products (especially vegetables and fruits) directly from local farmers was also a priority for agritourists in Michigan (Che D. *et al.*, 2006) and Tennessee (Jensen K. *et al.*, 2006). Also in Iowa, the study undertaken by Nasers M.S. (2009) highlighted an almost similar situation, with the difference that spending time together with the family or friends was a more popular reason than the opportunity to buy fresh agricultural products and to support of local farmers.

Jensen K. *et al.* (2006) established that the main visitors' preferences for the activities and services offered by Tennessee agritourism attractions are, in order of their importance, the following: purchasing fresh products, on-site restrooms, adequate parking, the opportunity to learn about the processes of obtaining or manufacturing the farm or business products, the location (accessibility) of the farms. A moderate interest was expressed by the agritourists for farm scenery, picnic areas and the opportunity to enjoy the presence of farm animals or pets. The purchasing of food and beverages or souvenirs and handicraft products is not very attractive for the visitors to agritourism establishments in Tennessee. The fact that the farm location and on-

site restrooms are important factors that influence tourists' decision to take part to agritourism is also evident from the study carried on Nasers M.S. (2009) in Iowa (USA).

According to previously mentioned research (Jolly D. and Reynolds K., 2005; Che D. *et al.*, 2006; Sotomayor S. *et al.*, 2011), it seems that the agritourists visiting American farms don't particularly feel the need to participate in agricultural activities or to improve their agricultural skills. This idea is also supported by the conclusions of other studies carried out in Europe and Asia. In Scotland, the most agritourists are less motivated by the agriculture-related features, such as the possibility of being involved in farm activities or observing agricultural activities (Gladstone J. and Morris A., 1998;

Flanigan S. *et al.*, 2015). In Turkey, the participation in agricultural festivals and events, adventure and involvement in farm activities are not priorities for agritourists (Artuğer S. and Kendir H., 2013), while, in Iran, learning and experimenting agricultural practices are not considered to be among the attractive agritourism services (Varmazyari H. *et al.*, 2018).

Based on their study in Thailand, Srikatanyoo N. and Campiranon C. (2010) stated that agritourism consumers are weakly motivated by the opportunity to improve their agricultural skills and to get involved in farm/agritourism activities, as well as by the opportunity to participate in agricultural events/festivals or to purchase agricultural goods (*table 3*).

Table 3

Summary of the Means - Agritourist Motivations and Needs (Srikatanyoo N. and Campiranon C., 2010)

Agritourist Motivations	Importance*	Agritourist Needs	Importance*
to relax mentally	4.19	beautiful scenery	4.25
to enjoy scenery	4.08	safety	4.22
to relax physically	4.07	clean and green environment	4.22
to enjoy life	3.93	convenience of restroom and shower facilities	4.14
to be in an agricultural environment	3.90	diversity of attractions	4.01
to discover new places and things	3.89	convenience of bedroom facilities	3.97
to escape from day-by-day stress	3.86	taste of food and beverage	3.90
to be together with family	3.85	easy to access	3.89
to improve health and wellbeing	3.83	attractions close to main touring routes	3.81
to build strength relationships	3.78	convenience of communication facilities	3.80
to get away from city life	3.70	educational opportunities about agriculture	3.72
to experience agricultural life and activities	3.69	activities that allow for family participation	3.64
to make friends or meet people with similar interest	3.56	participation in agritourism activities	3.60
to improve agricultural skills	3.52	agricultural goods purchasing opportunities	3.51
to attend agricultural event or festival	3.49	non-agriculture activities	3.39
to purchase agricultural goods	3.47		
to have an adventure	3.47		

* Based on five point Likert scale: from 1 ("very unimportant") to 5 ("very important")

On the other hand, Santeramo F.G. and Barbieri, C. (2017) believes that the agritourists are seeking, first off all, to reconnect themselves with the agricultural environment and local farmers. The visitors' preferences related to the agritourism services in a geographical area depend, in the opinion of Varmazyari H. *et al.* (2018), on the level of industrialization, the urbanization rate and the agritourism history in the respective area.

Based on the suggestions found in the literature, Ainley S. and Smale B. (2010) chose the most popular reasons for which tourists visit the rural area and the agritourism farms, these being divided into three categories of benefits: *family, relaxation, learning*. Their study conducted in Canada showed that these three dimensions of benefits are considered by all types of rural tourists as having almost equal importance. In the case of agritourists, which represented about 4.7% of the total rural tourists in Canada, spending time with family was the most mentioned reason, preceding

the desire for relaxation and the need to learning of new things.

In the UK, the favorite motives for practicing rural tourism are of psychological nature: „relaxation/well-being” (45%), „fresh air” (24%), „peace and quiet” (22%), „fitness and good health” (14%) (Countryside Commission, 1995).

Following the results of their study conducted in Finland, Tyrvaïnen L. *et al.* (2001) are of the opinion that the rural tourists are primarily motivated by the desire for change, relaxation and to experience something new. Establishing social contacts and having a pleasant time with family were found as relatively important reasons. Relaxation is the major motivating factor also in Komppula's opinion (2005), who states that Finnish rural tourists want primarily a quiet and stress-free vacation, to be in touch with nature and enjoy beautiful landscapes. Srikatanyoo N. and Campiranon C. (2010) achieved similar results in Thailand, where the

agritourists were mainly driven to visit farms in order to relax physically and mentally, to discover nature and to enjoy green environment (*table 3*).

In Turkey, the agritourists are strongly motivated to visit farms by getting relaxation in an agricultural environment, expressed through reasons like: „to enjoy the scenery”, „to enjoy life”, „to relax mentally”, „to improve health and well-being”, „to get away from city life”, „to relax physically”, „to escape from day-to-day stress” (Artuğer S. and Kendir H., 2013). The researches carried on in Korea by Park D. and Yoon Y. (2009) concluded that the primary motivations for rural tourism and agritourism were „family togetherness”, „relaxation”, „socialisation”, „learning” and „novelty and excitement”. These results confirm the conclusions of a previous study by Song D. (2005), which showed that the favorite reasons for Korean rural tourists were „escape from everyday life” and „family togetherness and learning”.

Devesa M. *et al.* (2010) examined the motives for tourists to visit rural areas of Spain, concluding that the most common reasons for this are: rest, tranquility and contact with nature (44.8%), culture (24%), proximity, gastronomy and nature (13.9%), returning to origin (17.4%). The results of another study carried out in region of Murcia (Spain) by Molera L. and Albaladejo P.I. (2007) indicated that the main benefits sought by rural tourists were, in order of their preferences: spending leisure time with family, relaxation, active rest, knowledge of rural life. The beautiful scenery and the natural environment were found by Canoves G. *et al.* (2005) as basic motivators for the rural tourists to visit the Spanish countryside.

A study regarding agritourism in India revealed that the tourists are primarily interested in the typically rural food, the opportunity to participate in farm activities and about entertainment possibilities, being less pretentious about the quality of accommodation facilities, accessibility and location of agro-tourism attraction and adequate parking facilities (Kumbhar V.M., 2012). A major preference to the consumption of local natural foods and fresh agricultural products was expressed, also, by the agritourists in Iran (Varmazyari H. *et al.*, 2018).

In Cyprus, the study conducted by Prokopis C. (2010) on the agritourism market segmentation based on traveler's motives or benefits sought by visiting farms, revealed that the most tourists were driven to the agritourism attractions due to the facilities/attributes of tourist destination (such as: authenticity, local traditions/customs, local traditional gastronomy, handmade art crafts) and the opportunity to perform outdoor or sports

activities (*table 4*). The reasons related to the natural environment or those of psychosomatic nature have proved to be of secondary importance.

Table 4
The main categories of agritourists, according to the reasons for visiting the countryside
(after Prokopis C., 2010)

Categories of agritourists	% of agritourists
“Destination driven”: ○ “authenticity seekers” ○ “gastronomy seekers” ○ “archaeology seekers”	29
“Activity driven”: ○ “walkers” ○ “cyclists” ○ “sport activity seekers” ○ “horse riders”	26
“Natural environment driven”: ○ “nature seekers” ○ “flora seekers” ○ “fauna seekers” ○ “bird watchers” ○ “entomologists”	17
“Tranquility/psychosomatic driven”: ○ “relaxers” ○ “escapists” ○ “nostalgia seekers” ○ “spirituality seekers” ○ “novel seekers”	16
“Personal attention/Hospitality driven”	10
Agritourists “for other reasons driven” to the countryside	2

Prokopis C.'s (2010) study indicates that the general satisfaction was expressed by the agritourists who stated that, in addition to meeting their both physiological and psychological needs and expectations, they also experienced the element of „pleasant surprise” at the tourist destination.

CONCLUSIONS

Individual particularities greatly influence the behavior of agritourism consumers, which represents a very heterogeneous category of tourists. The set of motivations for the agritourism experience is generated by a wide range of “push” and “pull” type of factors and it depends significantly on the context in which the tourist is found, related to his family situation, professional or health status. The importance of motivational factors of farm visitors varies greatly from one geographical region to another. As the most prevalent motivating factors for agritourism were found: physically and mentally relaxation, spending free time with family or friends, interaction with nature and opportunity to purchase fresh products directly from local farmers or to enjoy beautiful scenery. For agritourists,

participating at farm activities and learning about agricultural issues did not represented basic motivational factors to visit agritourism attractions.

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THE BENCHMARKING OF AGRICULTURAL PRODUCTION AND LABOR IN AGRICULTURE IN THE EUROPEAN PLAN

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Abstract

In this paper we propose a comparative analysis on European agricultural production and labor involved in this activity. Rural areas have a vital social role and a significant growth potential in society. There is a diminishing in reserves of manpower in rural areas throughout the EU, especially in emergent countries. The existing projections at this time, show a growing demand for agricultural products. For those who work in this field it is essential to be able to plan and predict medium and long-term activity. In this respect, we analyze the statistics of people working in some of the EU countries to have an overview of employment in the agricultural sector. The purpose of this paper is to investigate the evolution of the two factors that influence the agriculture and the macroeconomic stability.

With the increase in the share of industry and services in the economy, agriculture begins to be increasingly less attractive and available a large number of jobs in this sector. In this respect, an important role returns to farmers in sustainable economic development, diversification of the rural economy by creating new jobs and protecting the environment. But farmers by themselves without a concrete and immediate help from the authorities cannot succeed in reducing this alarming phenomenon.

In conclusion, agriculture is an important contribution to the EU GDP and has a fluctuating and uneven route across the European Union in terms of reporting the value of agricultural production to the number of farms, their size and manpower involved.

Key words: agriculture, farming, labor, crisis

Undoubtedly, according to the latest Eurostat statistics, agriculture is still big business. The contribution of agriculture to the GDP of the European Union was 1.2%, which is an important contribution. This article represents a real and objective analysis on developments in European Union member states. The data were processed according to Eurostat referring to the agricultural sector. In this analysis we address several important aspects. Firstly, we will discuss the potential of agriculture, i.e. the production of cereals in the EU. Secondly there are given in graphs and analyzes the development in cerealiere production, the number and structure of farms. It is showed that there are multiple possibilities for their growth. Closely related to farms it is also analyzed manpower involved in this sector and its trends.

In 2017 the agricultural industry registered a value of 432.6 billion euros. About half of this value came from four countries: France brings 16.78%, Germany 13%, Italy 12.73%, Spain 11.70%. To achieve approximate one quarter of that total, United Kingdom contributes 7.35%, Poland 5.75%, Romania 4.04% and Hungary

almost 3%. Given these data, the following conducted study makes a comparative analysis, in the eight countries previously mentioned, of the agricultural production, its value, farms and work force employed in this sector.

MATERIAL AND METHOD

The methodological and scientific analysis of this study has as support a direct and indirect research, such as the observation, the comparison, the synthesis. The qualitative and quantitative analysis of the agricultural area and that of human resources leads to an overall account of the studied economic phenomena and processes. The theoretical part of the research was based on studying the relevant literature regarding economy and management.

We bring out that Newbold, Karlson and Thorne show the efficiency of using statistics in economy. (Newbold P. *et al*, 2010). At the same time there was analyzed the information provided by international databases, like Eurostat data, which were processed and interpreted.

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RESULTS AND DISCUSSIONS

The European Union is divided into equal parts occupied by built-up areas, infrastructure, water as well as agricultural land and woodland. (Anghelache, C. *et al*, 2016)

In 2017, the land used for agriculture was of 179 million hectares. The agricultural area includes arable land, grassland and permanent crops, kitchen gardens, without taking into account woods, ponds or other fields that cannot be used for agricultural purposes. The agricultural area of each country depends on a variety of factors such as geographical position, related climate, types of soil, state of the economy, demographics. According to statistics, in the European Union there were 312.3 million tons of grain harvested in 2017. (Key figures on Europe, 2018)

At the European Union level the estimated value of EUR 432.6 billion integrated plant cultivation, breeding, agricultural services. More than half of this production came from cereals 10.7%, horticultural plants and vegetables 13.2%, fruit 6.3%, feed 5.3%, industrial plants 5.1%, wine 5.1%, olive 2.6%, potatoes 1.2%. The remaining value was brought by animals and animal products, first places being taken by milk and pork. An increasing role of approximately 8.5% in this value it is hold by the agricultural services that are becoming more important to the industry every year.

As far as the agricultural production is concerned, it shows a fluctuating trend generally slightly decreasing in recent years.

Table 1

Change of crops output at 1000 ha in the period 1990-2018

Country	1990	1999	2012	2015	2018
Average UE	34,181.17	-	58,078.38	57,640.29	55,509.88
Germany	6,948.31	6,534.70	6,527.30	6,276.20	6,148.90
Spain	7,553.30	6,696	6,169.89	6,195.86	6,014.81
France	9,050.50	8,841.60	9,377.68	8,575.54	9,050.46
Italy	4,406.70	4,173.30	3,577.76	3,084.18	3,134.43
Hungary	2,778	2,420.60	2,757.93	2,697.70	2,378.20
Poland	8,623.40	8,701.30	7,704.30	7,511.80	7,806.31
Romania	5,704	5,370.70	5,441.28	5,471.19	5,198.96
United Kingdom	1,646	1,294.10	3,142	3,091	3,178.20

Source: Eurostat, data processed by author (online at [aact_eaa01]) - Agriculture, forestry and fishery statistics, 2018

From the statistics produced results that agricultural exploitations are numerous and diverse in size, structure, administration, what grown, reared animals. (Ungureanu G. *et al*, 2013).

In the EU, in 2016 were counted 10.5 million farms. Romania ranks first with 32.7% of EU farms, it is followed by Poland with approximately 13.5%, Italy with 10.9% and Spain. Extensive research conducted in 2016 on agriculture brought out the following (Key figures on Europe 2016):

-96% are considered family farms, which means that they are administered in the family and at least half of agricultural work is carried out only by family workers. In countries like Romania, Italy, Spain, Bulgaria, Poland, Hungary, they constitute the majority. A different trend is

recorded by France and the United Kingdom. 27.3% of the farms in France are nonfamiliale and the United Kingdom has 38.6% of such farms;

-approximately 65.6% of farms have less than 5 hectares. The European average farm is 16.6 hectares, only 15% of all farms in the EU, having this size. Eurostat 2016 shows the following percentages based on the total worked farm land: farms up to 10 hectares have 12.1%, farms to 20 hectares have 8.3%, farms up to 30 hectares have 3.5%, farms up to 50 hectares have 3.6%, farms up to 100 hectares obtained 3.6% and farms larger than 100 hectares have 3.3% of total EU farms. It is interesting to note that the farms of at least 50 hectares worked 68.2% of the agricultural area;

-combining the size criterion with that of the legal form we came to the conclusion that EU

farms are the so-called semi-subsistence farms where production is mainly used to feed the farmers's family. The second category is represented by the small and medium farms, these being family business. The third group consists large farms which have a clear juridical legal form or are cooperative farms;

-diversity is the main word when we characterize types of farms. There are considered several criteria, such as the dominant activity, what is grown or cultivated, farm specialization. Thus, a farm specialization refers to the fact that two thirds of the size of the farm is dedicated to that specific activities. Other farms have a mix of activities, hence the difficulty of strictly falling under a classification criterion. Considering the stated information, we can say that in 2016, 52.5% of farms were specialized in cultivation of which 16.4% strictly for harvesting, 15.2% cereals and various kinds of seeds, 7.6% olive, 5.1% citrus and fruits and 4.3% grapes, 1.8 % vegetables and 1.9% combined farms presented above. In the same year, 25.1% of the total were farms specialized in breeding as follows: 6.2% sheep and goats, 9.1% cattle and milk production, 4.5% chickens, 1.5% pigs, 2.6% granivorous animals. Mixed farms occupied 21.1% of all farms, being divided as follows: 10.1% of cereals and animals, 4.7% mixed farming, 6.3% animal rearing and pastures, 1.3% unclassified farms.

Of the analyzed countries, it can be concluded that in Spain and Italy, over 60%

dominate farms specialized in crop production, in France 54%, Germany 67% and the United Kingdom 75% majority are farms that rear animals, and in Romania, Poland and Hungary most are mixed farms, the percentage being over 30%.

In *tables 2 and 3* we conducted a comparative analysis for the period 2005 to 2016 of the number of agricultural farms, the land measured in hectares used for agriculture, the agricultural production value and manpower involved in this sector. It stands clear that developed countries such as Germany, Spain, France and United Kingdom have fewer farms but manage to work a greater number of hectares resulting a high value of the output of agricultural production using a small number of workers.

In emerging countries, the majority from the former communist bloc, and even in Italy, there is a problem which resides from the mentality regarding collaborative work. Distrust of others led to a large number of farms using inefficient an average number of hectares, the value of agricultural production being low given the fact that they use a large number of people. Hungary, Poland and especially Romania have a high agricultural potential. Due to a faulty organization of agriculture, these countries have failed to achieve the expected results in accordance with their efforts and available resources. (Anghel M.G. *et al*, 2017)

Table 2

Distribution of farms reported the labor force in agriculture during 2005-2016

Country	2005		2010		2016	
	Number of Farms	Employee annually	Number of Farms	Employee annually	Number of Farms	Employee annually
Germany	389,880	643,230	299,130	545,000	276,120	490,060
Spain	1,079,420	992,640	989,800	888,970	945,020	801,160
France	567,140	855,490	516,100	779,660	456,520	708,170
Italy	1,728,530	1,374,260	1,620,880	953,790	1,145,710	874,950
Ungary	714,790	462,740	576,810	453,670	430,000	391,730
Poland	2,476,470	1,014,950	1,506,620	1,897,240	1,410,700	1,649,400
Romania	4,256,150	2,595,590	3,859,040	1,610,260	3,422,030	1,587,650
United Kingdom	286,750	110,370	185,200	265,660	185,860	285,760

Source: Eurostat, data processd by author (online at [ef_m_farmleg])- Agriculture, forestry and fishery statistics - 2018

Table 3

The evolution of hectares used in agriculture and the Standard output (SO) in the period from 2005 to 2016 euro in agriculture

Country	2005		2010		2016	
	Hectaries agricole	SO-EURO	Hectaries agricole	SO-EURO	Hectaries agricole	SO-EURO
Germany	17,035,220	44,408,435,780	16,704,040	41,494,097,650	16,715,320	49,249,020,560
Spain	24,855,130	33,625,081,990	23,752,690	34,173,689,600	23,229,750	38,365,605,150
France	27,590,940	46,527,554,360	27,837,290	50,733,216,720	27,814,160	61,343,138,670
Italy	12,707,850	40,328,283,810	12,856,050	49,460,329,710	12,598,160	51,689,024,310
Hungary	4,266,550	4,921,939,060	4,686,340	5,241,037,240	4,670,560	6,532,474,660
Poland	14,754,880	16,084,089,030	14,447,290	18,987,070,900	14,405,650	25,005,635,420
Romania	13,906,700	13,906,700	13,306,130	9,874,585,200	12,502,540	12,105,491,800
United Kingdom	15,956,960	18,695,147,080	16,881,690	19,554,979,690	16,673,270	25,403,447,340

Source: Eurostat, data processed by author (online at [ef_m_farmleg]) - Agriculture, forestry and fishery statistics, 2018

At EU level it is interesting to watch the data on the workforce involved in agriculture. In the period from 2005 to 2016 the average amount of work declined by about -2.5%, and in 2017 only -1.2%, but the trend is of the same decrease. There are important differences between Member States, Spain experienced an increase of 5.1% and Bulgaria, for example, a decrease of -6.9%. Detailed data related to this activity are rare, a

thorough analysis being carried out by 2013. (Mărcuță A. *et al*, 2016)

Agriculture is still a major employer especially in developing countries such as Romania with 23% of employees in 2018 the same recorded in Poland with 9.5%. Overall, in the EU, the number of people working in agriculture is 4.3% of total employment, as shown in *table 4*. (Agriculture, Forestry and Fishery Statistics, 2018)

Table 4

Employment rate of labor in agriculture (%)

Country	2015	2016	2017	2018
Average UE	4.8	4.6	4.4	4.3
Germany	1.5	1.4	1.4	1.4
Spain	3.9	4.0	4.0	3.8
France	2.8	2.7	2.7	2.7
Italy	3.7	3.7	3.6	3.6
Hungary	6.3	6.0	5.8	5.4
Poland	11.5	10.6	10.2	9.5
Romania	26.4	23.8	23.5	23.0
United Kingdom	1.3	1.3	1.3	1.2

Source: Eurostat, data processed by author - Agriculture, forestry and fishery statistics, 2018 edition

According to Eurostat official statistics, a large part of total agricultural labor was the self-

employed, about 6.9 million workers with individual labor contract in 2017. In the long run, in the European Union the development in employment presents a fluctuating framework which depends on several factors such as seasonality, progress in mechanization and hence

production efficiency, more employment opportunities in other sectors of the economy. (Mărcuță A. *et al*, 2014) There were exceptions to this trend, including the following Malta and Ireland, countries which are not found in the tables.

Table 5

Employment in the agriculture, forestry and fishing (age from 15-64 years, thousands)

Country	2009	2012	2015	2018
Average UE	10,171.1	9,652.4	9,057.3	8,347.1
Germany	589.5	554.9	511.3	474.8
Spain	770.3	729.7	724.8	797.9
France	733.0	722.5	693.6	641.6
Italy	784.3	778.5	785.8	810.8
Hungary	170.4	191.0	202.7	210.1
Poland	1,990.0	1,869.0	1,792.8	1,516.7
Romania	2,261.3	2,185.2	1,900.2	1,657.3
United Kingdom	280.7	297.4	286.3	282.5

Source: Eurostat data processed by author, (online data code [lfsa_egan2])

CONCLUSIONS

Studies have led to several theoretical and practical conclusions. Through its 28 member states the European Union shows that it occupies one of the first places at global level in agriculture, both in terms of number of farms, land used for this purpose and value of agricultural production.

These small farms can play an important role in reducing the risk of poverty in rural areas, providing additional income and food.

Regarding the workforce involved in agriculture in the European Union there are at least two trends related to this issue. Regarding developed countries, they have a small weight and less fluctuating employment in agriculture, but fewer people are interested in working in this field. Through politics which seek freedom and facilitate labor mobility in the Union, these countries manage to attract labor from Eastern European countries. However, emerging countries generally the Eastern European ones have a higher rate of employment in this area and show a downward trend. At the same time they face a situation where many people go to work in agriculture in developed countries leading to a shortage of labor in this sector.

Through the foregone investigations, it appears that Romania has a great potential in the

agricultural sector, but it must comply with European Union standards, notably through better management of the fund arable resources, production and labor in agriculture.

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MICRO-CREDIT APPLICATIONS AS A STRUGGLE AGAINST WOMEN POVERTY: A CASE STUDY OF ISPARTA PROVINCE, TURKEY

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Abstract

The micro-credit applications used as a struggle against women poverty in Isparta province were examined in this study. The main material of the study was comprised of original data acquired via face to face interviews with 212 women micro-credit users in the city of Isparta. It was determined based on the study results that 62.26% of the women micro-credit users were between the ages of 30-49, 54.25% had low education levels (primary school), 87.74% were married with an average family size of 3.76 people. It was observed that 87.26% of the women had social security and that the monthly family income of 40.09% varied between 1001-1500 TL. Majority of the women (58.49%) indicated that they used the micro-credit for developing their already existing businesses. It was set forth that the women used the micro-credit mostly in areas of commerce (43.87%), handwork/embroidery (28.30%) and animal husbandry (19.34%). The women indicated that their social relations and self-confidence increased as a result of the credit. About 80% of the women stated that there was a little increase in their family income after the micro-credit and it was determined that majority of the women (89.62%) want to use micro-credit again. Of the women who participated in the study 68.40% suggested an increase in the amount of credit while 51.89% suggested longer payment periods between two installments.

Key words: women, poverty, micro-credit, Grameen Bank

The struggle of people with poverty dates as far back as the history of humanity. Almost all the countries in the world have struggled against poverty regardless of their levels of development. These efforts were sometimes carried out by way of government and private institutions and sometimes via aids, donations etc.

Poverty for women emerges as a more meaningful and important issue (Ören K. *et al*, 2012). Women, children and the elderly are actually considered as disadvantageous groups with regard to poverty and there is a need for positive discrimination for this group. Hence, various means of struggle are tried to be determined to minimize women poverty. One of these means of struggle is "Micro-Credit Applications". Micro-credit is a type of credit that is given to women who want to start a business but do not have the sufficient income. It is maintained that micro-credit as a small amount of unsecured and direct capital based solely on trust for strengthening unity and solidarity is an important tool for ensuring that the poor saves itself from poverty as a result of their own efforts (Akgül A., 2014).

Micro-credit application is based on the "Grameen Bank" foundation that emerged in 1976

as a result of the ideas and efforts of Muhammed Yunus, a professor of economy at the Chittagong University in Bangladesh on how banking services can be provided to people with small income at rural areas. Grameen Bank is a type of bank that Muhammed Yunus started by giving 27 dollars as capital to 42 poor people in a village in Bangladesh on the condition of paying it back within a year which became more systematic over time. Grameen Bank yielded successful results with this micro credit application in helping poor people in rural environments to start their own businesses and over time save themselves from poverty (Latifee H.I., 2006).

The applications of the bank were actualized in 81 countries all over the world including USA and various European countries along with Kosovo, Bosnia Herzegovina, Ecuador, Nigeria, India, Vietnam, Mexico, Nepal and China (Yunus M., 2003). Micro-credit applications attracted the attention of international institutions such as the United Nations, World Bank and IMF. United Nations declared 2005 as the "International Year of Micro Credit" and decided to present micro credit as an effective tool in reducing poverty (IYOM, 2005).

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The micro-credit application that is widely used in the world has also gained popularity in Turkey. The purpose of this study was to examine the micro credit applications used as means of struggle for women poverty in Isparta Province, Turkey. For this purpose; the demographic properties of women micro-credit users were determined as well as the activities they used the micro-credit for, the changes that took place as a result of the credit in their income levels and social lives and whether they are willing to reuse the credit or not. In addition, issues related with the use of the micro-credit were determined as a result of which various suggestions were provided for making the application more effective.

MATERIAL AND METHOD

The main material of the study was comprised of original data acquired via face to face interviews with women micro-credit users in the city of Isparta. Moreover, similar studies carried out by related people and institutions have also been used. Questionnaire data covers 2017.

According to the Turkey Grameen Micro Finance Program Isparta Branch records, a total of 467 active members were determined who have used micro-credit in August 2017 when the sample group was calculated for the study. The study was based on Simple Random Sampling Method which is one of the Probability Based Sampling Methods (Altunışık R., *et al*, 2012). The aforementioned method was used with a margin for error of 5% and confidence interval of 95% for calculating the sample number as 212. Data acquired via questionnaire application were analyzed using MS Excel and SPSS software after which they were interpreted by tables.

RESULTS AND DISCUSSIONS

All women above the age of 18 experiencing economic difficulties and who have a goal and business idea to overcome these difficulties or those who are willing to start a business with a small capital can benefit from the micro-credit application. *Table 1* presents the age groups of women micro-credit users. According to the table, majority of the women were determined to be in the 40-49 (31.60%) and 30-39 (30.66%) age groups. The ratio of these two age groups among the total number of women micro-credit users was calculated as 62.26 %. The age group with the lowest percentage among women micro-credit users was the group of women aged 60 and above (9.43%). It can be observed from the table that women in the age intervals of 30-39 and 40-49

have used micro-credits the most. The reason for this can be indicated as the fact that majority of the women in these age groups are married and have children and thus need additional income for their families. Öz C.S. and Çolakoğlu C., (2014) carried out a study in which it was put forth that women in the age intervals of 18-25 and 56+ do not show much interest to the micro-credit application (7.82% and 14.4%), but on the contrary women in the age groups of 26-35 and 36-45 are more interested in micro-credits (34.4% and 27.8%) (Öz C.S. and Çolakoğlu C., 2014).

Table 1
Distribution of women by age groups

Age groups	n	%
18-29	24	11.32
30-39	65	30.66
40-49	67	31.60
50-59	36	16.98
60+	20	9.43
Total	212	100.00

Table 2 presents the educational status of women micro-credit users. It was determined that majority of the women micro-credit users were primary school graduates (54.25%). This was followed in order by high school graduates (31.60%), university graduates (8.02%), literates (5.66%) and illiterates (0.47%). Based on these results, it was determined that primary school and high school graduate women were among the highest women micro-credit users. It was observed that the micro-credit demand of university graduates was lower. Apaydın S. and Altunç Ö.F., (2015) carried out a study in which it was presented that primary school graduates were the highest women micro-credit users with a percentage of 40.5% and that the lowest percentage of women micro-credit users were those with bachelor's and graduate degrees (Apaydın S. and Altunç Ö.F., 2015).

Table 2
Educational status of women

Educational status	n	%
Literate	1	0.47
Illiterate	12	5.66
Primary school	115	54.25
High school	67	31.60
University	17	8.02
Total	212	100.00

Table 3 shows the marital status of women micro-credit users. It was determined that majority of the women micro-credit users were married (87.74%). We can state that married women use micro-credits more due to encouragement from

their spouses and for meeting the needs of their children. Tüzün Rad S. and Altıkulaç S., (2016) carried out a study in which it was concluded that married women used the highest number of micro-credits with a percentage of 78.4% which was followed by widowers with a percentage of 13.5% and single women with 8.1% (Tüzün Rad S. and Altıkulaç S., 2016).

Table 3
Marital status of women

Marital status	n	%
Single	7	3.30
Married	186	87.74
Widow	15	7.08
Divorced	4	1.89
Total	212	100.00

The distribution of women according to the number of children is presented in *table 4*. Women with two children made up the group with the highest percentage (42.93%). This was followed by women with three children (32.13%). The total percentage of women with two and three children was 75.12%. Women with two and three children were determined as women with the highest percentage of micro-credit use among all other women. The percentages of women with 4 children and those with 5 children and above were determined to be low. This can be due to the fact that women with many children have to spare more time for their homes resulting in low demands for micro-credit applications. The average family size of women micro-credit users was determined as 3.76 in the present study.

It was determined that majority of the women micro-credit users (87.26%) have social security and that the percentage of women without social security was 12.74%.

Table 4
Number of children

Number of children	n	%
No	8	3.90
1	33	16.10
2	88	42.93
3	66	32.19
4	6	2.93
5+	4	1.95
Total	205	100.00

Table 5 presents the previous jobs of women micro-credit users prior to using micro-credit. Accordingly, it was determined that majority of the women were housewives (49.53%) and self-employed (39.15%) before micro-credit use. Based on these results, it is observed that

housewives and self-employed women have more demand for micro-credit applications. It can be indicated that housewives use micro-credit for contributing to the family income and carrying out their hobbies while self-employed women use micro-credits for improving their existing jobs.

Table 5
Previous job before using micro-credit

Previous job	n	%
Self-employed	83	39.15
Housewife	105	49.53
Worker	18	8.49
Officer	1	0.47
Retired	5	2.36
Total	212	100.00

Table 6 shows the family incomes of women before using micro-credit. The study results show that women with a monthly income of 1001-1500 TL were ranked first with a percentage of 40.09 %. It was determined that about 80% of women had a family income below 2000 TL before micro-credit use. This sets forth that micro-credit user women had low family incomes. Tüzün Rad S. and Altıkulaç S., (2016) carried out a study in which it was put forth that women with a family income of 1000-1500 TL made up the group with the highest micro-credit use percentage with 40.05 % (Tüzün Rad S. and Altıkulaç S., 2016).

Table 6
Family income before using micro-credit

Income groups (TL)	n	%
0-500	7	3.30
501-1000	16	7.55
1001-1500	85	40.09
1501-2000	61	28.77
2001+	43	20.28
Total	212	100.00

TL: Turkish Lira; 1USD=3.65 TL in 2017 (average)

The sources used for reaching the micro-credit target groups are very important. It is required to select the tools to inform the target groups of the micro-credit and to ensure that these target groups have easy access to these sources. *Table 7* shows the information sources of micro-credit for women. Accordingly, it was determined that micro-credit user women were informed of micro-credits mostly from their friends and other people around them (91.98%), while mass communication tools such as television-newspaper had the lowest percentage (0.47%). It was concluded that micro-credit sources should use more effective tools to reach a greater number of people. For example, tools such as local newspapers, televisions, radio and internet can be

used for this purpose. Because, it is observed based on the findings that the percentages for both the credit offices and media such as TV, newspaper etc. are quite low. Aslan Ö.F. and Ekinçi E.D., (2015) carried out a study in which it was determined that 50% of the participants were informed of the credit from the people around them who have used micro-credits before, 46.7% were informed by their relatives-friends-close acquaintances, 2.5% from visual-printed media and 0.8% from other sources (associations, party, foundations, etc.) (Aslan Ö.F. and Ekinçi E.D., 2015).

Table 7

Information source of micro-credit		
Information source	n	%
TV, newspaper, etc.	1	0.47
Friends-other people	195	91.98
Credit office	16	7.55
Total	212	1.89

The purposes of using micro-credit for women are presented in *table 8*. Accordingly, it was determined that women use micro-credits mostly for improving their existing jobs (58.49%). This was followed by setting up a new business (28.77%). It can be observed that the purposes for majority of the micro-credit user women (87.26%) revolve around two purposes (improving the existing job and setting up a new business). Therefore, it can be put forth that women have used micro-credits either for improving their already existing jobs that they work at with their spouse or for setting up a new business with an entrepreneurial spirit.

Table 9 shows the number and amount of micro-credit used by women. According to the data presented in the table, it was observed that almost half of the women (48.58%) used 5 or more credits. Thus, the fact that 212 of the micro-credit user women have used 5 and more credits indicates their high demand for the credit system, that they have benefited from the credits they used and thus want to use credit again. In addition, it was determined as a result of the interviews carried out with the participant women that a total of 1 487 050 TL micro-credit have been used from 2009 to 2017. The average amount of credit per woman was determined as 7014 TL.

The production branches for which the credits have been used are given in *Table 10*. It was determined that 43.87% of the women used the credit in commerce activities. This was followed by handwork/embroidery (28.30%) and animal husbandry activities (19.34%). It was also observed that plant production (3.77%) is not

preferred by women as much as animal husbandry activities (19.34%) and that the animal husbandry activities are carried out by women in rural areas mostly as ovine production and trade.

Table 8

Purposes of using micro credit		
Purposes	n	%*
Set up a new business	61	28.77
Improving the existing job	124	58.49
To be partner for a job	3	1.42
Cash needs	28	13.21
Child expenses	7	3.30
Pay off credit debt	2	0.94
Other	1	0.47

*percentages are higher than 100 because of multiple choice

Table 9

Number and amount of micro-credit used		
Number and of micro credit	n	%
1	28	13.21
2	34	16.04
3	26	12.26
4	21	9.91
5+	103	48.58
Total	212	100.00
Total credit amount (TL)	1 487 050	
Credit amount (TL/Women)	7 014	

Table 10

Production branches using micro-credit		
Production branches	n	%*
Animal husbandry	41	19.34
Plant production	8	3.77
Commerce	93	43.87
Handwork/Embroidery	60	28.30
Haberdashery	12	5.66
Peddler	4	1.89

*percentages are higher than 100 because of multiple choice

Table 11 shows information on the status of employment in businesses started with the micro-credit. Accordingly, it was determined that majority of the women (81.13%) are working themselves at the business started or improved. The percentage of women working together with their husbands was determined as 12.74%. The percentage of worker women was determined to be very low (0.94%). This puts forth the fact that the businesses setup by the women with the micro-credits they used are not large enough to have other people work for them.

Table 11

Employment status		
Who is working?	n	%
Herself	172	81.13
Husband	7	3.30
Worker	2	0.94
She and her husband	27	12.74
She and her child	4	1.89
Total	212	100.00

Table 12 shows the out of purpose use for micro-credits. As can be seen from the table, 71.70% of the women have used the credit on purpose and that 28.30% have used the credit out of purpose. Thus, it was determined that more than half of the women have used the micro-credits to fulfill their purposes for applying to the credit. It was observed that more than half of the women who used the credit out of purpose (68.33%) used the credit for their home needs. The home needs were followed by child needs with a percentage of 30% and health expenditures with a percentage of 13.33%. Şengür M. and Taban S., (2011) carried out a study in which it was put forth that of the women who used the micro-credit out of purpose 50.3% used it for household expenses, 14.9% for other expenses, 10.1% for school expenses of children, 9.5 % for emergency situations, 2.4 % for health expenditures and 1.5 % for wedding-engagement expenses (Şengür M. and Taban S., 2011).

Of the interviewed women, 76.89% indicated that they experienced no problems when using the credit while 23.11 % indicated that they experienced some problems. Of the women who have experienced problems, 77.55 % stated that they had difficulties in paying credit installments while 20.41 % stated that they experienced problems in the group. Installments cannot be paid on time especially due to low sales amounts. It was determined that some group members did not participate in the weekly meetings carried out at homes and that they could not pay the weekly installments on time.

Table 13 shows the effect of micro-credit on family income. It is important to observe and evaluate the changes in family income in order to understand whether micro-credits are effective or not. As can be seen from the table, 71.70% of the women stated that there was a little increase in family income after micro-credit use, 8.96% indicated that there was a lot of increase while 19.34% indicated that the family income has not changed. In general, it was observed that women who have used the credit to set up a new business or improve their existing jobs have been able to

increase their incomes thereby contributing to their family income.

Table 12

Out of purpose of micro-credit use		
Out of purpose use	n	%
Out of purpose	60	28.30
For purpose	152	71.70
Total	212	100.00
Reasons for out of purpose use	n	%*
Home needs	41	68.33
Health expenditures	8	13.33
Child needs	18	30.00
Other	10	16.67

*percentages are higher than 100 because of multiple choice

Table 13

The effect of micro-credit on family income		
Change of family income	n	%
It has not changed	41	19.34
There was a little increase	152	71.70
There was a lot of increase	19	8.96
Total	212	100.00

Some women living in cities and in rural areas experience difficulties in having access to existing opportunities and resources. Providing them with these resources will enable them to develop or increase their expectations from life as well as their efforts. Women who reach their goals as a result of these efforts will also receive positive returns both financially and spiritually by establishing a place for themselves. Table 14 shows the effects of micro-credits on social relations. Accordingly, it was observed that 69.34% of the women had more friends after micro-credit use, 22.64% became more active, family relations of 11.79% improved and that people's behaviors were better towards 7.08%.

The satisfaction status of micro-credit user women is presented in Table 15. It was determined that majority of the interviewed women (93.40%) were satisfied of the credit they used. Bayraktutan Y. and Akatay M., (2012) carried out another study as a result of which it was presented that 82.4% of micro-credit user women were satisfied of using credit, 13.7% were moderately satisfied and 3.9% were not satisfied (Bayraktutan Y. and Akatay M., 2012).

Of the interviewed women, 89.62% stated that they want to use micro-credit again while 10.38% stated that they do not want to use micro-credit again. As a result, it is observed that majority of the micro-credit user women are

satisfied and that they want to use credit again. Bahar H.S. and Kurşunel F., (2014) carried out a study in which it was put forth that 83.5% of the women want to use micro-credit again (Bahar H.S. and Kurşunel F., 2014).

Table 14
The effect of micro-credit on social relations

Change of social relations	n	%*
People's behavior was better	15	7.08
My family relations improved	25	11.79
I had more friends	147	69.34
I became more active	48	22.64
Other	12	5.66

*percentages are higher than 100 because of multiple choice

Table 15
Women's satisfaction status

Satisfaction status	n	%*
Yes	198	93.40
Uncertain	8	3.77
No	6	2.83
Total	212	100.00

Table 16 shows the opinions of women on the negative aspects of the credit. Accordingly, more than half of the women (72.17%) stated that there were no negative aspects. Of the participants who indicated negative aspects, 16.98% pointed out weekly payments as a negative aspect, while 8.02% indicated purchase of compulsory goods from the credit office and 4.25% not being able to get credit when they want from the credit office as negative aspects. These results put forth that some of the credit user women experienced problems during the process of getting credit or after using credit. Required precautions should be taken by micro-credit providing institutions in order to provide better service with higher quality to micro-credit user women.

Recommendations of micro-credit user women for the application of micro-credit are given in table 17. Majority of the women (68.40%) stated that the amount of credit should be increased. This was followed in order by recommendations for longer payment periods between two installments (51.89%), support of authorities (governor, mayor etc.) (16.98%) and greater number of installments to be able to use more credit in a short amount of time (10.38%).

Table 16
Negative aspects of micro-credit

Negative aspects	n	%*
None	153	72.17
Weekly payment	36	16.98
We can't get credit when we want	9	4.25
Purchase of compulsory goods from credit office	17	8.02
Other	11	5.19

*percentages are higher than 100 because of multiple choice

Table 17
Recommendations for the application of micro-credit

Recommendations	n	%*
The amount of credit should be increased	145	68.40
Payment period between two installments must be longer	110	51.89
Authorities should support sale of products	36	16.98
Number of installments should be increased	22	10.38
Other	4	1.89

*percentages are higher than 100 because of multiple choice

CONCLUSIONS

It was determined that majority of the interviewed women were in the 30-39 and 40-age group, with low education levels, married and with two or three children. The results of the present study showed that the family income for 80% of the women was below 2000 TL before using micro-credit. It was put forth that women used micro-credit more for improving their already existing jobs. This was followed by setting up a new business. Half of the women used 5 and more credits since 2009. It was determined that the women use the credit mostly for commerce, handwork/embroidery and animal husbandry businesses. It was determined that 23.11% of the women experienced problems regarding the micro-credit and that the most important problem was related with the payment of installments. It was also determined that majority of the women recommended that the amount of credit should be increased and that there should be longer periods between the payment of installments. The following suggestions have been made based on the acquired results:

- Care should be given to give priority to women struggling with poverty followed by other women who want to carry out entrepreneurial activities in order to ensure that the micro-credit application does not stray from its original objective.
- Micro-credit user women should be supported by professionals with regard to the type of business they can start based on their skills and desires since majority of the micro-credit user women have low education levels.
- The efforts of women may sometimes be insufficient for selling their products. Required environment and marketing opportunities should be provided for this purpose.
- The amount of credit given should be increased.
- Weekly installment application for a period of 46 weeks is considered by the women as a negative aspect of the application. Hence, having installment payments every 2 weeks will ensure that the payments will be made more comfortably.
- Out of purpose use of micro-credits should be prevented.

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