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CONTENTS

MECHANIZATION IN AGRICULTURE

Mechatronic system for controlling the sowing rate Dimitar Kehayov, Ilian Bojkov	3
Examining of Water Distribution Uniformity in Drip Irrigation Systems: A Review of Various Recent Studies Worldwide Bilal Acar, Sena Afacan, Nasuh Açık	6
Methodology for experimental testing of the reliability of agricultural machinery Miho Mihov, G. Davchev, G. Tasev	9
Basic principles of aggregation of hinged agricultural machinery Ivan Morteve	14
Assessment of machines in reliability test Miho Mihov, Davchev, G. Tasev	16
Trial model of a combined machine for inter-row tillage in perennial crops Ivan Morteve	19

CONSERVING OF THE RESOURCES

Neglected and underutilized crop species a path to improving nutritional security and diversification of agriculture Pirro Icka, Robert Damo	22
Advanced Review on Soil Microbiology and Fertility of Soils Suresh Aluvihara, T.E. Weerawardena, H.D.A.K. Gunaratne, D.V.R.I. Deniyapahala	27
Noise loading in beehives made out of different materials Todorka Lepkova, Lyuben Lakov	32
Comparison of Energy Savings Measures in Plant Fruit Storage Facility Giorgio Mustafaraj1 Irida Markja, Klodian Dhoska	35

Mechatronic system for controlling the sowing rate

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Abstract Maintaining the set sowing rate is important to obtain an accurate number of plants and guarantee good yields. This can be achieved by mechanical systems - variators and gear reducers or by electric drive (mechatronic systems). The object of the present work is the device of a mechatronic system for setting and maintaining the sowing rate when sowing cereals. Dependencies are derived for determining the transfer function in the control mechatronic system. Its principle and structural schemes are presented

Keywords: MECHATRONIC SYSTEM, SOWING RATE

1. Introduction

When growing cereals, sowing is one of the most responsible operations, as the correctly chosen technology, the exact setting of the sowing rate depending on the specific soil and climatic conditions, determine the future yields. In row drills, one of the most promising and reliable, with good quality indicators and precise setting of the sowing rate, is the mechanical drive through reducers or variators. Changing the sowing rate with the help of a reducer has some significant disadvantages, which affect the deterioration of the accuracy when setting it, decrease the uniformity of seed distribution, increase the traumatized seeds, which leads to a decrease in yields and an increase in the cost of seed material [1, 2]. The drive of seeders with a variator is more promising, but at the moment it is poorly studied.

More and more often, work is being done to replace the mechanical gearbox for driving the shaft of seed drills with an electric drive [3]. When sowing oil crops, the use [4] of seeders controlled by an electronic system is promising. It has been established that for sowing rapeseed and other small-seeded crops, a planter equipped with an electronic seed metering device meets all agrotechnical requirements and works much better than those equipped with a mechanical transmission system. Practically does not damage the seeds, allows very precise setting of the required sowing rate, ensures stable sowing and uniform distribution of seeds in and between rows.

The authors [5] propose a practical solution to improve the performance of the precision corn planter by using a mechatronic system to drive the sowing apparatus. The effect of the application of this system is reduced to: improving the index of missing seeding, the presence of such a system allows operation at a speed of ≥ 11 km/h without a change in quality, eliminating the effect of slippage of the drive wheels on the quality of seeding and to maintain the even distribution of seeds.

Studies show [6] that a precision planter equipped with a mechatronic system showed good seeding uniformity among all seeding technologies at travel speeds from 1 to 16 km h⁻¹. Thus, a mechatronic metering mechanism can be one of the options to achieve accurate seed spacing with higher planting/sowing efficiency and the ability to reduce the effect of higher seeding rates. A mechatronic drive system, when coupled with a pneumatic seed drill, can effectively reduce the effect of speed on seeding accuracy, with a 4-8% increase in feed quality index and a 4-7% decrease in gap index observed. It also solves the wheel slip problem of existing precision planters. Good seeding uniformity and high productivity are achieved.

The combined machine for the processing of soil and sowing has some innovative solutions such as: an electronic control unit and an automatic system for maintaining the depth of seed placement [7]. The improved design and operational characteristics of soil cultivation and sowing with a combined machine allow to expand its versatility and precision of work, providing useful agronomic effects: stable maintenance of the set sowing rate, increasing the speed of movement of the machine and, as a result,

achieving a high productivity, the achievement of uniform seed germination.

Dosing machines use mechatronic systems to drive and control the dispensers, replacing traditional mechanical systems composed of a drive wheel, chain and gear. Mechatronic systems allow continuous, real-time variation of the administered dose. A mechatronic system for the control of fertilizer and granular pesticide dispensers was developed, which was adapted to a fertilizer planter [8] The system is based on microcontrollers as processing and control devices, as well as DC motors with encoders to drive the dispensers. Changes in the administered dose are achieved by controlling the rotation frequency of the dosing devices using the pulse width modulation technique. The implementation of a mechatronic speed control system for the fertilizer and granular pesticide dispenser allows a response time of less than one second at frequencies ranging from 5 to 35 rpm.

The application of electronic systems for managing the sowing rate has its difficulties. It was established, [9] that traditional automation and control systems have a complex structure. The presence of redundant modules and interfaces leads to a decrease in the reliability of control systems, deterioration of their mass, size and cost indicators. The solution to the problem of interfaces is possible by applying the mechatronic approach, where elements are combined into integrated modules and unnecessary interfaces are removed. In this way, the performance of the control systems is improved. It has been proven that the development of software and hardware systems for automation and control with a mechatronic approach can be based on the Arduino platform.

From the overview, it can be seen that more and more efforts are being made to replace the mechanical drive of the seeders with a mechatronic one. With this method of drive and management, stable maintenance of the set seeding rate is achieved, increasing the speed of the machine and achieving higher productivity, uniform placement of the seeds, overcoming the influence of slippage on the amount of seeds sown. To build a mechatronic system for controlling the sowing process, it is necessary to determine the transfer function in the system.

The aim of the present work is to develop a mechatronic system for controlling the sowing rate when sowing cereals. The tasks that need to be solved to achieve this goal are: determining the transmission function in the drive system of the seeders and determining the necessary components for building a mechatronic control system.

2. Results

To adjust the seeding rate, the transmission ratio in the system driving the seeding devices must be precisely determined.

Transmission of movement from the running wheel to the drive shaft of sowing devices is usually carried out using the transmission mechanism (several toothed chain and toothed gears) of the seeder [1, 2, 10]. A characteristic of the operation of any transmission mechanism is its gear ratio i . The realization of the sowing rate for a given crop depends only on the transmission ratio in the transmission mechanism. For this, before determining the structure

of the control system, it is necessary to determine the transmission function (transmission ratio) of the planter, expressed with its technical and technological parameters.

For 1 revolution of the drive shaft, each sowing device takes out a certain quantity q_2 [kg] of seeds from the seed hopper. Since m number of sowing devices are installed on each seeder, the amount of seeds carried out for 1 revolution of the drive shaft can be determined by the expression:

$$Q_2 = q_2 \cdot m, \text{ kg/revolution} \quad 1$$

Drive shaft revolutions are n_{CA} [min⁻¹]. By multiplying the amount of seeds sown in 1 revolution of the drive shaft by this speed, the amount of seeds sown in 1 min by the whole planter is obtained:

$$Q_{1m} = Q_2 \cdot n_{CA}, \text{ kg/min} \quad 2$$

The amount of seeds sown in 1 min by the seeder, expressed through the operating parameters of the unit, can also be represented with the following dependence:

$$Q_{1m} = \frac{B_p \cdot V_p \cdot Q}{60} \quad 3$$

The left-hand side of formulas 2 and 3 is the same, which means that their right-hand sides are equal.

$$\frac{B_p \cdot V_p \cdot Q}{60} = Q_2 \cdot n_{CA} \quad 4$$

It is known that the working width (B_p) is the product of the row spacing (b) and the number of boots.

$$B_p = m \cdot b, \text{ m} \quad 5$$

By substituting formulas 2 and 5 into formula 4 and rationalizing the new expression is obtained

$$b \cdot V_p \cdot Q = 60 \cdot q_2 \cdot n_{CA}, \quad 6$$

In the above equation, the velocity can be replaced by $V=0.12 \cdot \pi \cdot n \cdot R$, whence it follows

$$b \cdot 0.12 \cdot \pi \cdot n \cdot R \cdot Q = 60 \cdot q_2 \cdot n_{CA} \quad 7$$

The expression 7 can be rationalized and after transformation will have the form

$$b \cdot n \cdot R \cdot Q = 159,236 \cdot q_2 \cdot n_{CA} \quad 8$$

The rotational speed of the seed drill shaft can be represented as the product of the rotational speed of the driving wheel and the gear ratio. After substitution and rationalization in the above expression, we get

$$b \cdot R \cdot Q = 159,236 \cdot q_2 \cdot i \quad 9$$

Analyzing equation 8, it can be seen that the inter-row distance and the radius of the running wheel of the row drill are constant values. The same can be said for the amount of seed that will be sown in one revolution of the seeder. This value can be obtained experimentally. The only thing that needs to be changed to realize different sowing rates for the same crop is the transmission ratio, regardless of the change in the speed of the unit.

$$i = \frac{b \cdot R \cdot Q}{159,236 \cdot q_2} \quad 10$$

In the above formula, the amount of seeds q_2 that are sown is directly dependent on their density and volume. The size of the row spacing b and the radius of the drive wheel R are constant values for each particular planter. This gives reason to claim that the transfer function is a function of one variable - the sowing rate Q

After finding the transmission ratio, all the necessary input parameters are present and the construction of the mechatronic system for stepless control of a cereal planter can be started.

In order to switch to stepless regulation of the sowing rate, the following or a similar mechatronic block diagram must be implemented (fig.1).

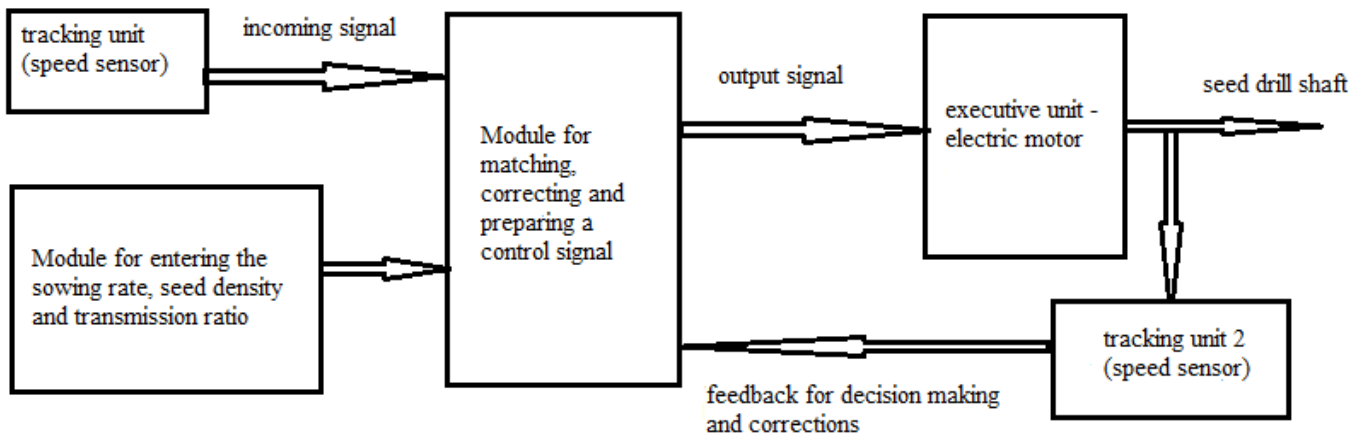


Fig. 1 Schematic diagram of the system for stepless regulation of the sowing rate.

Various electrical and electronic components operating in a wide range of supply voltage can be used to build the system. In the project, we choose a working voltage of 12 V, which is provided by the tractor battery in the unit or on-board electrical system. The information for determining the speed of the sowing unit is supplied from the on-board computer of the tractor through the CAN Bus Module to the microprocessor (microcomputer) Arduino (fig.2). The data on the size of the row spacing, the sowing rate, the density of the seeds, the transmission number are entered from the keyboard

and via the I2C bus enter the microprocessor. Also connected to the same bus is a display that visualizes the entered data. On the basis of the input data, a control signal (PWM) is created, which through an electronic module (Driver) commutating a larger current, drives the DC motor. The engine has a built-in encoder or tachogenerator that feeds back information to the microprocessor to make the necessary adjustments to maintain the required revolutions.

All considered elements of the mechatronic system are in great variety on our market.

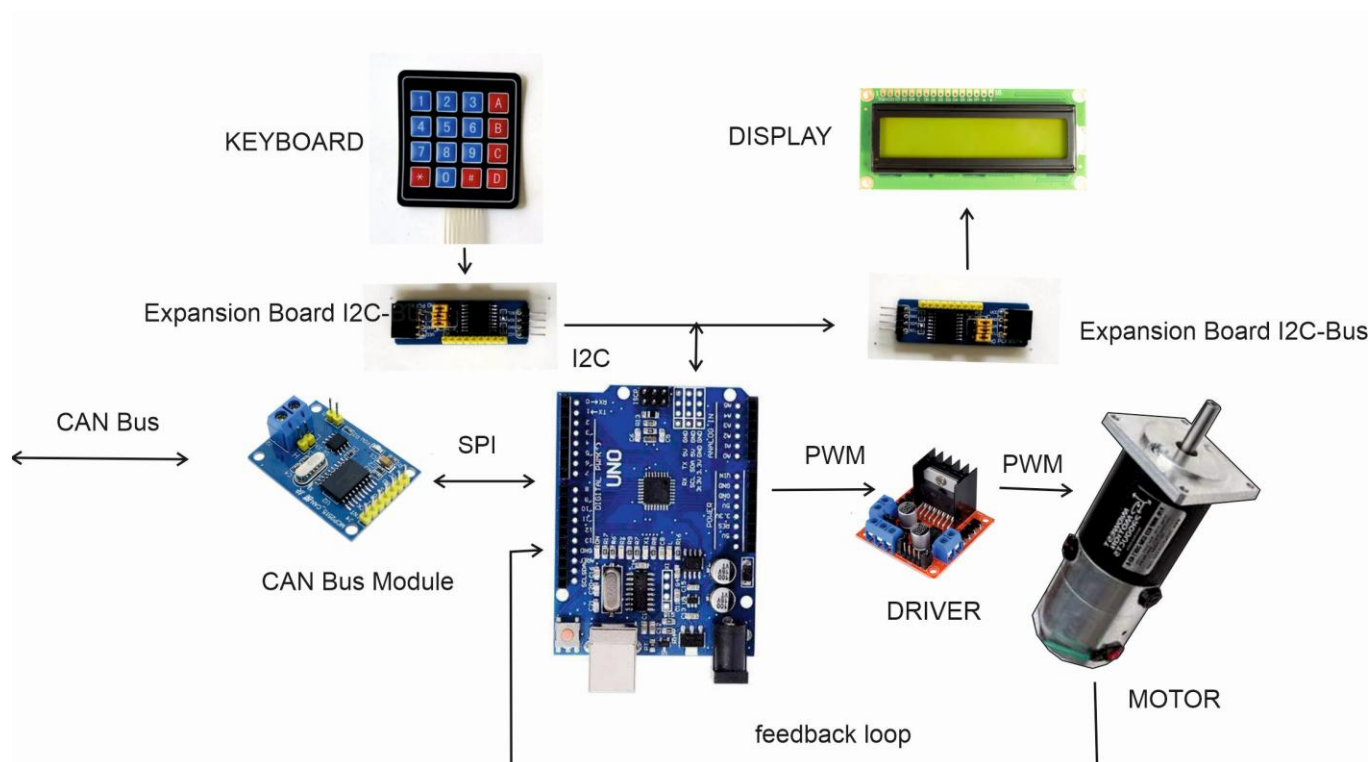


Fig.2 Device of the mechatronic system for regulating the sowing rate

4. Conclusions

As a result of the literature review and the conducted analysis, the following conclusions can be drawn:

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The transmission ratio (transmission function) can be presented as a function of the sowing rate;

The mechatronic system for controlling the sowing rate can be built from elements that are in great variety on our market.

Examining of Water Distribution Uniformity in Drip Irrigation Systems: A Review of Various Recent Studies Worldwide

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Abstract: This study was aimed to evaluate water application uniformity of emitters for drip irrigation systems. The data was obtained from our previous studies or some researches in the world relevant to watering performance of drippers. In results, reasons of poor watering performance of drip irrigation systems were inadequate design and mainly incorrect management of systems. Following recommendations were proposed for better distribution of water for crops / plants; 1- correct design and management of the systems, 2- applications of physical, chemical, and biological for preventing dripper clogging, 3- timely control of system components particularly emitters, and 4- participation of farmers courses about agricultural water management.

KEYWORDS: WATER DELIVERY, EMITTER, MANAGEMENT OF IRRIGATION SYSTEMS.

1. Introduction

There are various artificially water application methodologies for crops. The way that is introducing of water to crops is called as irrigation method. It is effective strategy for improving crop production in areas with insufficient rainfall. The main target in irrigation process is to apply water to plants with minimal losses.

The possibly drip irrigation is the most innovative irrigation method for application of water for crops with high uniformly. It allows more water savings and can be strongly recommended in regions with low amount water resources which is not suited for surface irrigation systems utilization [1,2]. By comparison to the rain-fed or surface irrigation systems, drip irrigation may improve crop production as 20%-80%, and water saving as 30%-70% [3].

There is no doubt that better watering productivity results more areas bringing into irrigation as a consequently increment in net returns of landowners. The main issue for water managers is to apply water by emitters onto crops or within crop rooting systems with high uniformity [4]. The water distribution uniformity is affected many factors such as operating pressure, emitter spacing, land topography, diameters of water delivery pipes, variations in emitter flow rate and emitter manufacturing, emitter clogging, and aging of partial or complete system components [5,6].

The differences between dripper flow rates should be lower than 10% for achievement of acceptable water distribution uniformity [7,8]. Emitter is backbone of drip irrigation system, and soil characteristic, crop water consumption, dripper discharge, and irrigation water quality is very important role to play in emitter selection [9].

The major aim of the current study is therefore to analysis some criteria's for interpreting water application uniformity of drippers.

2. Materials and Methods

In current study, following parameters were used for determination of water application uniformity;

A- Emitter Flow Rate Variation (Q_{var})

$$Q_{var} = \left(1 - \frac{q_{min}}{q_{max}} \right) \times 100$$

Where; q_{min} - Lowest flow rate (L/h), q_{max} - Highest flow rate (L/h).

Q_{var} is greater than 20% is not acceptable [10].

B- Uniformity Coefficient (UC)

UC can be expressed as [11];

$$UC = \left[1 - \left(\frac{\Delta q}{q_{avr}} \right) \right] \times 100$$

Where; UC- Uniformity Coefficient, %

Δq – Mean of absolute deviation from mean flow rate, L/h

q_{avr} –Mean flow rate, L/h

The relationship between UC and watering class was presented at Table 1 [12].

Table 1. Relationships between UC and Water Application Uniformity

UC, %	Water Distribution Class
> 90	Perfect
80 – 90	Good
70 – 80	Moderate
60 – 70	Poor
< 60	Unacceptable

C- Emission Uniformity (EU)

$$EU = \frac{q_{25\%min}}{q_{avr}}$$

Where; EU-Emission Uniformity (%), $q_{25\%min}$ - Mean of the lowest quarter of emitter flow rates (L/h), q_{avr} - Mean flow rate of emitters (L/h).

The relationship between EU and watering class was presented at Table 2 [10].

Table 2. Relationships between EU and Water Application Uniformity

EU, %	Water Distribution Class
>94-100	Perfect
81-87	Good
68-75	Acceptable
56-62	Poor
< 50	Unacceptable

3. Results and Discussions

There was found direct relationships between working pressure and dripper flow rates with use of emitters having no pressure compensating. In that regard, determination of correct operating pressure is one of the important design parameters in micro irrigation system design. In one study [10], Q_{var} values were found acceptable, Q_{var} is lower than 20% for operating pressure between 0.4 and 1.2 kg/cm² under in-line dripper uses (Table 3). The lowest Q_{var} value as 10.6 % was obtained from 1.2 kg/cm² operating pressure. In other word, emitter watering performance was stated as **Acceptable** under working pressure of 1.2 kg/cm².

Table 3. Q_{var} and EU values for different operating pressures [10]

	Operating Pressure (kg/cm ²)							
	0.3	0.4	0.6	0.7	0.9	1.0	1.1	1.2
Q_{var} (%)	33.3	15.2	12.7	22.6	13.6	15.8	11.4	10.6
EU (%)								

Emitter flow rate was researched at Konya province of Türkiye. In that study, average dripper discharge was 2.57 L/h that is lower than recommended value of 3.8 L/h by Producer Company. The reason was stated as much seepage losses from pipe lines. Therefore, it was strongly suggested that drip irrigation whole components should be controlled regularly for achieving satisfactory water applications to the crops [13].

The well-known indicator for assessment of dripper water application efficiency is UC. The UC value for calculated as 94.6% in study performed at drip irrigation system using at Public Park situated at Konya province, Türkiye. The watering performance of such drippers was classified as **Perfect** [13]. In that study, although there was no found many differences among emitter flow rates, all discharges of drippers were lower than the value suggested by pipe production company. Therefore, irrigation system should be scheduled by using actual flow rate of 2.57 L/h.

In other study [14], the UC value was reported as 95%. In accordance of that value, the emitter watering performance was stated as **Perfect** [12].

The UC and EU values varied from 84% to 68% (**Good** and **Poor** watering Uniformity, and from 71% to 44% (**Poor** and **Unacceptable** watering uniformity) at drip irrigation systems using corn fields situated at Konya-Çumra province, Türkiye [15].

The EU values varied from as about 80% to 95% depending on the applied working pressure on system [10]. There was found almost no difference between 1.0 kg/cm² (94.5%) and 1.2 kg/cm² (94.8%) operating pressures. The maximal EU value was obtained as 94.8% from 1.2 kg/cm² working pressure (Fig 1). The watering class was **Excellent** in accordance of this result. In that case, working pressure of both the 1.0 and 1.2 kg/cm² could be advisable for satisfactory water application across to the fields.

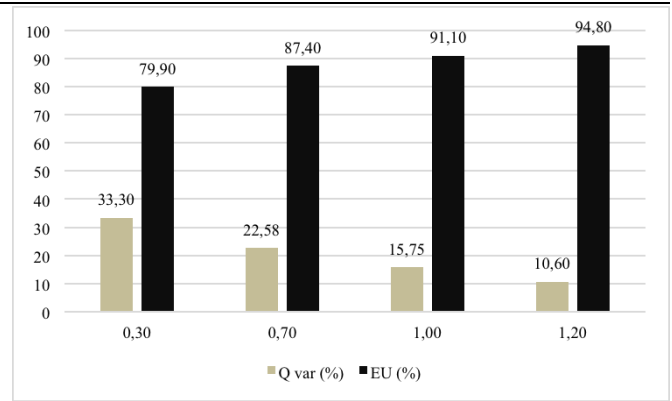


Fig 1. Q_{var} and EU accordance of different operating pressures [10].

The study performed at Ghana [16] about determination of water application efficiency of drip irrigation systems for loamy-Sand or Sand condition using one-year old drip lines with 30 cm emitter spacing showed that UC as 78% (**Fair** water application), and EU as 90% (**Very Good** water application). It was stated that the emitter watering performance could be improved by regular cleaning filters, controlling pressure reduction, cleaning the gates of filters, and flushing of drip-lines at minimum two or three times a year.

The most important factor lowering water distribution uniformity is emitter clogging. In that case, emitter clogging can be prevented by some ways. The innovative emitter clogging prevention methodologies were given in a study [17].

Table 4. Innovative emitter clogging treatment methodologies [17]

Prevention methods	Explanations
Physical	Use of filters and flushing emitters or drip-lines
	Magnetization of irrigation water
	Application of MERUS ring: Separating the big particles by using MERUS ring and making them easy for flushing out those small particles.
	Pulsating and dynamic pressure application
Chemical	Treatment of water with ultrasound
	Application of small amount of fertilizer in necessary time
	Application of N-holamine nano particles (NPs)
Biological	Electro-chemical application
	Treatment via various antagonist bacteria strains such as <i>Basillus</i> spp., <i>Burkholdria</i> ssp., and <i>Basillus amyloliquefaciens</i> .

4. Conclusion

In outcomes of the present study, sustainable use of water resources is necessarily prerequisites particularly water shortage ecologies such Konya Closed Basin of Türkiye. One of the most important significant interests is application of water saving irrigation systems like drip irrigation with great care. In that context, irrigation water should be applied as uniform as possible on around the rooting systems for maximal crop production. Some factors such as poor design of systems, and differences in land slopes can affect watering uniformity. Beside those, emitter clogging resulting from water quality, or damages or aging of lateral tubes is the reason of poor water application performance. In general, there are three main improvement methodologies for solving emitter-clogging problems: physical, chemical, and biological methodologies. They should be applied in accordance of sources of emitter clogging. The drip irrigation is an advance technology, needs specialist background, so farmers should be informed about drip irrigation system management with some practical activities.

Conflict of interests

The authors declare there is no conflict.

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Methodology for experimental testing of the reliability of agricultural machinery

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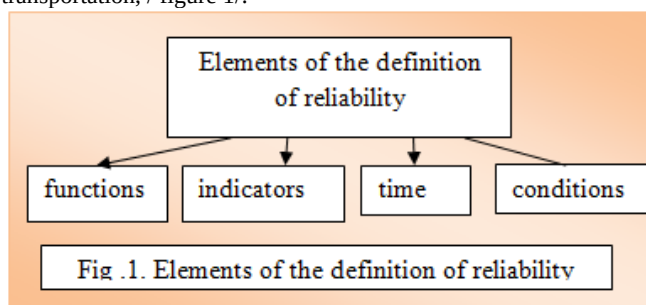
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Summary: The types of machine reliability tests and the applicability of the test plans are discussed. On this basis, a methodology for experimental testing of the reliability of the machines is proposed and the interrelation of the elements of the methodology is shown.

Keywords: machines, agricultural machinery, parameters, criteria, test plan, average value, dispersion, coefficient of variation,

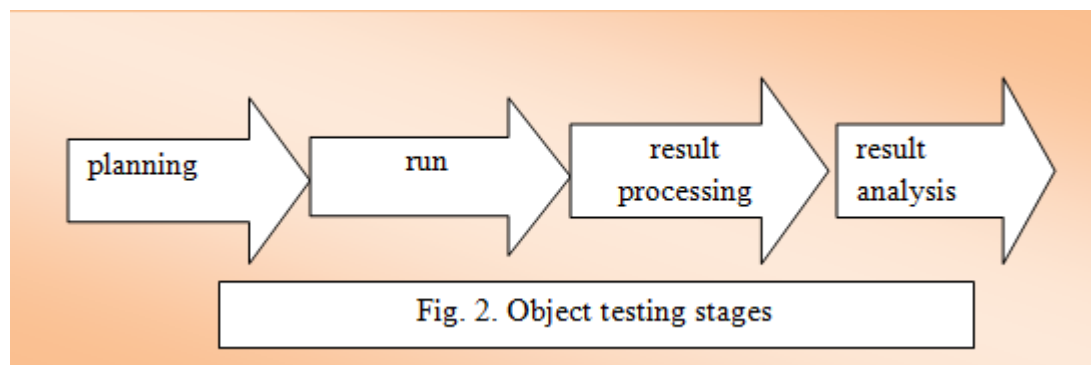
The idea of justified comparison of the same type of machines has been developed, ie. machines with the same functional purpose, using statistical criteria to prove the significance of the difference in the characteristics of the reliability indicators.

Reliability is a complex property of an object to perform certain functions, maintaining over time the values of the established indicators within certain limits, corresponding to certain modes and conditions of operation, maintenance, repair, storage and transportation, / figure 1/.

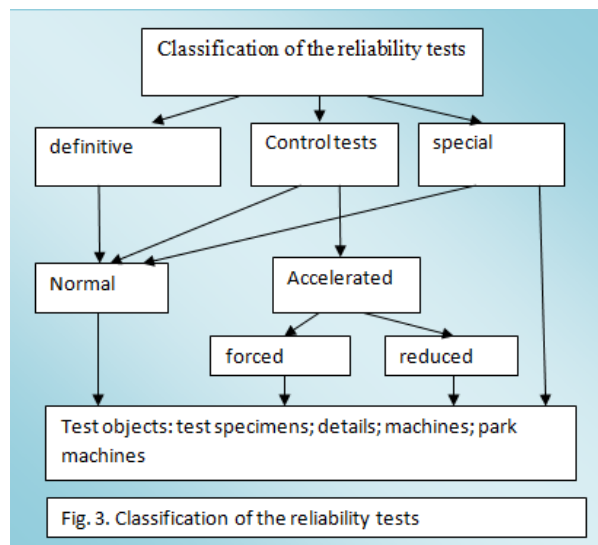


The essence of the definition of reliability and its elements also determine the main elements of the methodology for experimental testing of objects for the determination of the indicators and characteristics of the basic and properties / reliability, durability, maintainability and storage / and for comparing the types of objects with the same purpose, but produced from different companies or organizations.

The purpose of the reliability test is to experimentally determine the quantitative and qualitative characteristics of the properties of objects at work, to simulate operating conditions and / or to reproduce the effects on objects under a given program. There are four stages to each test: test design, test run, test result processing, result analysis and decision selection, / figure 2/.



The subject of our research will be the following stages: test planning, processing of test results, analysis of results and taking management decision.



The nature of the test types given in Figure 3 is as follows:

- **Definitive tests** are carried out to obtain quantitative estimates of the numerical characteristics of the reliability indicators, to verify that the values of these indicators are not less than a certain value;
- **Control tests** are carried out to determine the conformity of mass-produced production with the requirements specified in the technical conditions;
- **Special tests** are conducted to determine the influence of a factor on the level of reliability of the site;
- **Accelerated tests** are conducted to obtain information on the reliability of the sites in a shorter timeframe compared to the operating conditions;
- **Forced trials** are conducted to obtain information in a short time at the expense of acceleration by increasing load, temperature, speed and other factors;
- **Reduced tests** are conducted to obtain information about the compaction of the tests over time, ie. shortening of idle times and downtime, continuous work around the clock, etc.

The experimental test methodology is identical in all types of tests with respect to its basic elements and is shown in Figure 4.

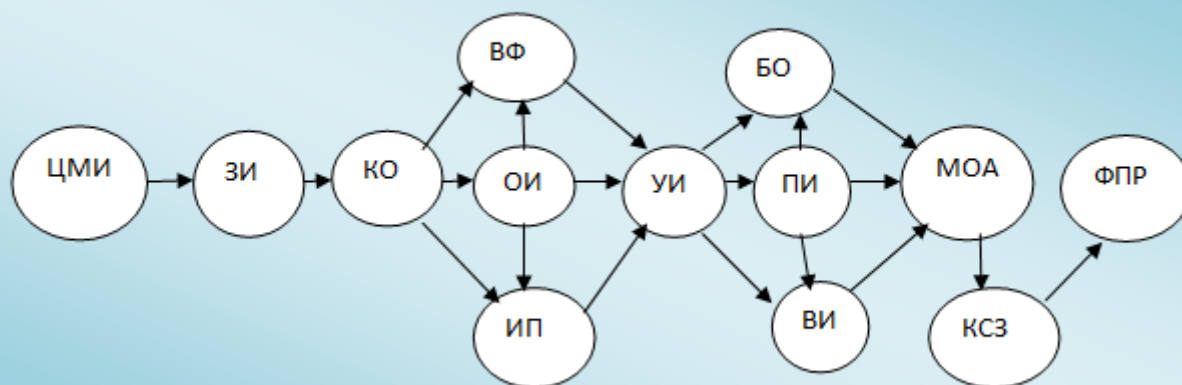


Fig. 4. Structure and interrelation of the elements of the experimental testing methodology at the level of reliability of the machines: (ЦМИ) - purpose of the testing methodology; ЗИ - test tasks; КО - criteria for assessment of the condition of the site; ОИ - test subject; ВП - input factors; ИП - output parameters; УИ - test conditions; ПИ - test plan; БО - number of objects; ВП - test time; МОА - methods for processing and analysis of test results; КСЗ - criteria for the statistical significance of test evaluations; ФПР - form of presentation of test results

We will look at the following basic elements of the methodology for experimental testing of machines:

Failure or limit criteria. Failure or limit state criteria are referred to as distinguishing signs of failure or limit state of the machine. As a distinctive feature can serve the basic parameters of the object, the change of which characterize the transition of the object from working to inoperable or in a limiting state.

Depending on the nature of the parameters used for the distinguishing feature, the criteria for failure or limit state can be: technical, technological, economic, aesthetic, environmental and ergonomic.

Test plan. Observation planning means the choice of the site, the conditions for conducting the operational observations and the test / observation plan (establishing the number of observation sites and the duration of the observation).

According to the research plan, the latter are divided into the following main groups: [NUN]; [NUT], [NUR], [NRT], [NRR], where U means a plan in which failed objects are not replaced by new "Unrepaired"; R – means a plan whereby failed objects are replaced with new or "Repaired" ones.

Within the limits of this classification, the following plans shall also be used:

[1RT] – the object of test is a single product which, failing, is replaced by a new or refurbished over a fixed construction T_i ;

[1RT] – the object to be tested is a single product which, by refusing, is replaced by a new or refurbished to a fixed number of failures r ;

[NUT ($r = 0$)], [NRT ($r = 0$)] - N articles are the subject of the test and the failures are replaced or not during the manufacture T no failure is registered.

If, in a test plan, objects are switched on or replaced by tests at the same time, "not rigorous" plans are indicated not by square brackets, but by parentheses. For example: (NUT) is such a plan in which some of the products are later included or removed from testing prior to completion of the T production.

If, during the test, the control of the operation is performed periodically at specified intervals (construction), then the relevant designations are:

[[NUT]] is a plan of test without regeneration for a fixed production T, wherein the controlling operation is performed periodically;

((NUT)) – the same plan, but the objects do or do not take the test at the same time as the design T. It is assumed that the moments of receipt or removal of the products during the test coincide with the moments of control.

Finally, the boundary layer, when the products are not replaced, the test continues until a certain design is made, and the control is carried out only before the start and after the test. This is the so-called "non-parametric" test scheme and is referred to as [NUT hk]

Generally, in the reliability test, three types of random variables (conversions) can be obtained from which the sample consists:

1. Complete conversions, these are random dimensions of making a failure (between failures);
2. Incomplete conversions, ie random variables expressing the manufacture up to the time of termination of the test or withdrawal of the test article before failure;
3. Conditional conversions represent some fixed value - production up to the moment of control in which a failure is detected, ie. a value known only to the effect that the actual value of the manufacture does not exceed a given fixed value. This is a common type of experimental data relevant to cases where controls are carried out at discrete times.

The conditional graphic designations of these conversions are presented in Figure 5. If the test is terminated when the test fails, the complete realization shall be indicated by a encircled cross.

The monitoring plan shall be selected according to the objectives of the study

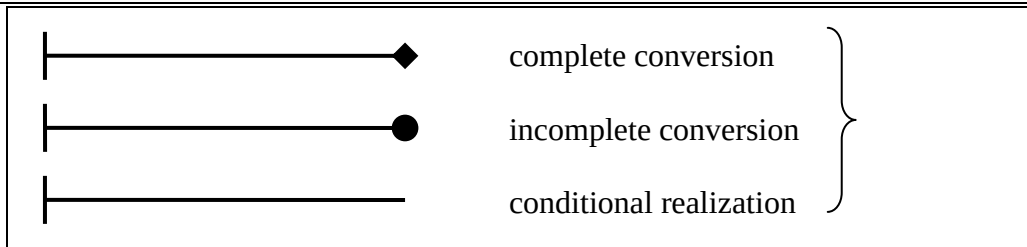


Fig. 5. Graphic Conversion Label

For each of the monitoring plans indicated, the elements of the objects that have reached the limit state are replaced according to the plan with new or repaired ones, but the information about the newly placed elements is reported separately and remains in the array of information of the given object (machine).

Observation of a particular complex object (eg tractor) is terminated if it is sent for full repair (ie the machine has reached a limit state) due to its general technical condition, or if two of the main units for the observation period (engine, gearbox, rear or drive axle) have reached the limit state and are to be replaced.

When developing a monitoring plan, it is necessary to take into account the following points related to the possibilities of using the different collection methods and types of information to evaluate the integrity of sites:

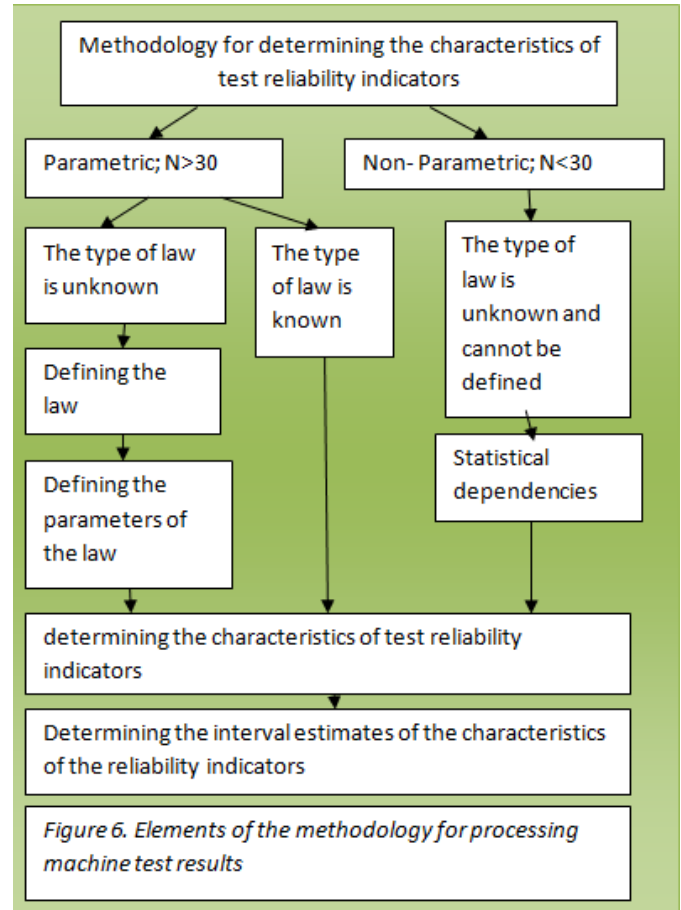
(a) Data on the trouble-free operation of the machinery under operational conditions shall be obtained by conducting continuous monitoring from the beginning of the use of the site to a particular manufacture, calendar duration or condition. In the course of such observations, data are also obtained about the resource of the main elements of the site (construction to the limit state);

(b) Information on more complex failures of elements (including workmanship to the limit state) that are remedied and the consequences are recorded in the economic records can also be obtained through periodic observations that take place over a period of time;

(c) The estimation of the resource of the elements of the objects can be made with sufficient accuracy using the methods of wear forecasting and the various diagnostic parameters of the condition.

(d) The data on the change of the parameters of the condition and the wear and tear can be obtained at carrying out the periodic inspections using the means and methods of technical diagnostics, at the technical expertise of the failed elements or at the arrival of the objects in the repair enterprises.

Methodology for determining the characteristics of test reliability indicators, / fig. 6/.



The characteristics of the machine reliability indicators are random variables, the numerical characteristics of which are given in Fig. 7.

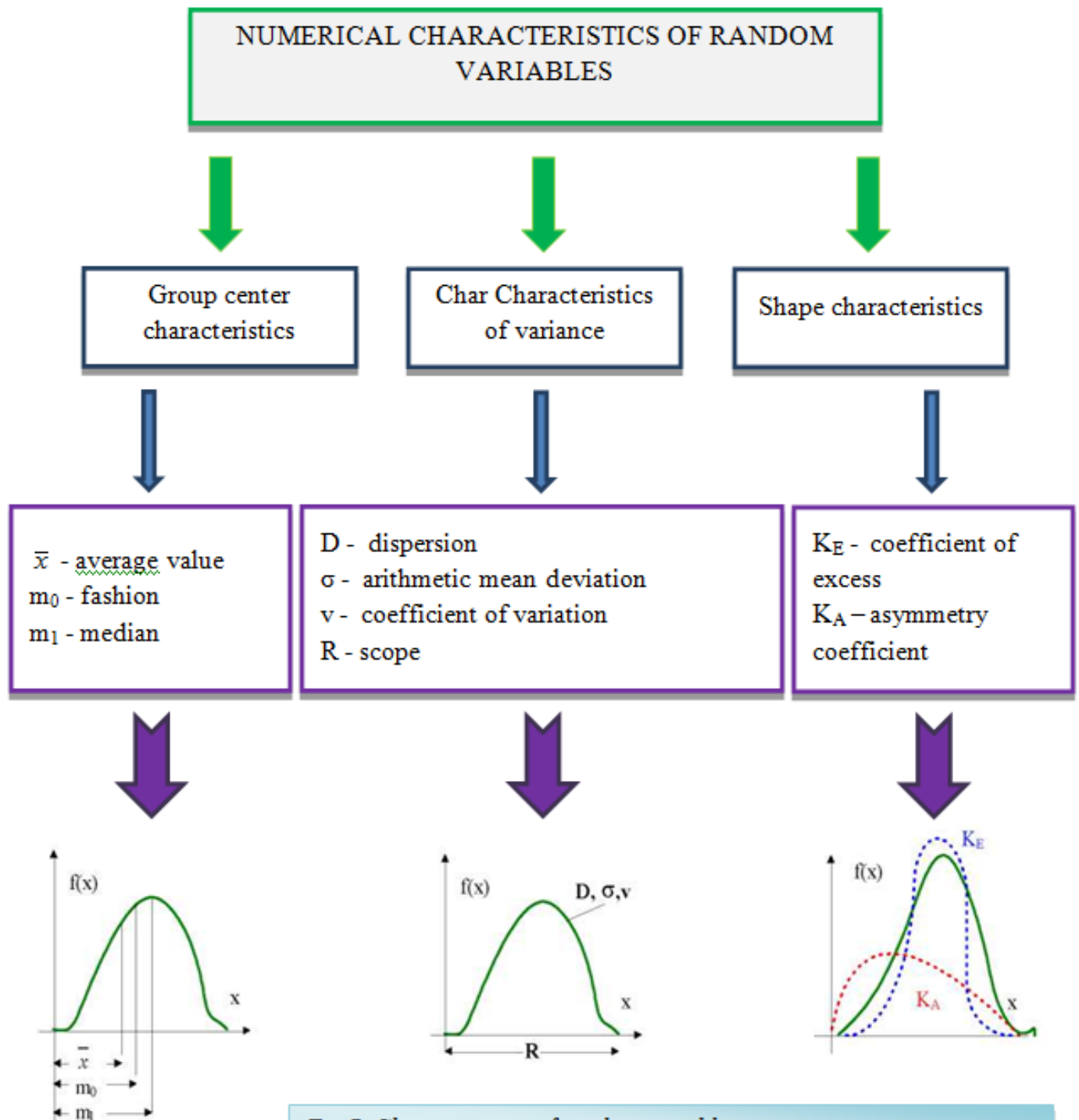


Fig. 7. Characteristics of random variables

When conducting an experimental testing of machines, it is of interest to compare the individual samples and to select better or more appropriate criteria. Very often, when testing different machines, it is necessary to evaluate the statistical significance of the results obtained, ie. whether differences are statistically significant or not.

Two groups of criteria are used to provide a reasoned answer and to

prove the statistical differences or indistinguishability of the test results: parametric (Student's criteria) and nonparametric (Man-Whitney criteria).

The essence of the statement comparing the statistical significance of the characteristics of the reliability indicators is given in Fig. 8.

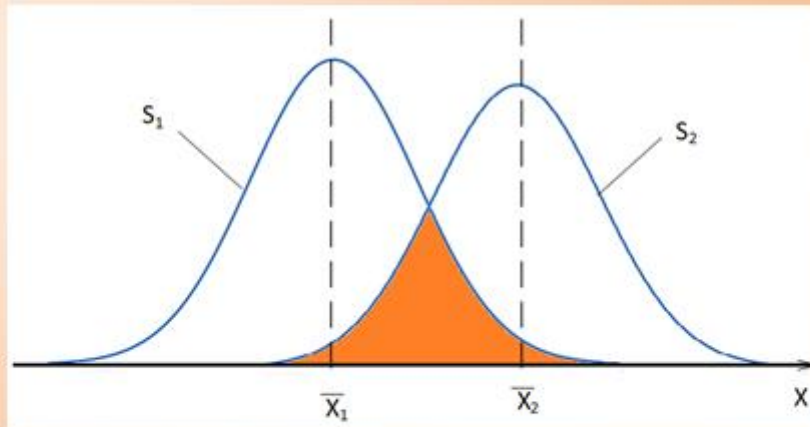


Fig. 8. Model comparing the statistical significance of differences: X_1 is the assessment of the average test parameter of the first model machine; X_2 -second model machine; S_1 and S_2 , respectively, are the root mean square deviation of the first and second machine models

Main conclusions:

1. A methodology for the experimental testing of machinery reliability is proposed and the interrelation of the elements of the methodology is shown.
2. The machine-specific elements of the proposed methodology for the experimental testing of machines are justified.
3. The idea of justified comparison of the same type of machines has been developed. machines with the same functional purpose, using statistical criteria to prove the significance of the difference in the characteristics of the reliability indicators.

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Basic principles of aggregation of hinged agricultural machinery

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Summary: Rules for aggregating mounted agricultural machines have been systematized. Dependencies are derived for determining the parameters of the tractor after aggregation with the machine and the rules for safe work according to the norms are given.

Introduction

An essential part of the agricultural machines are hinged, they do not have their own running system and must use the running system of the tractor. This changes the technical characteristics of the tractor's running system. In order for the tractor to be operational and safe for work and transport, a number of requirements must be met. Both the technical parameters of the tractor and the machine take part in formulating these requirements. In order to correctly assemble the mounted machine and to comply with the rules for safe operation with it, it is necessary to comply with some basic rules presented in this study.

Purpose of the study

To derive dependencies for the calculation of the parameters related to the aggregation of the hinged agricultural machines.

When aggregating a mounted machine, it is necessary to calculate the actual values for the total weight of the tractor, the axle load of the tractor and the load capacity of the tires, as well as the required minimum balancing, which is sufficient load on the front axle to ensure safe handling.

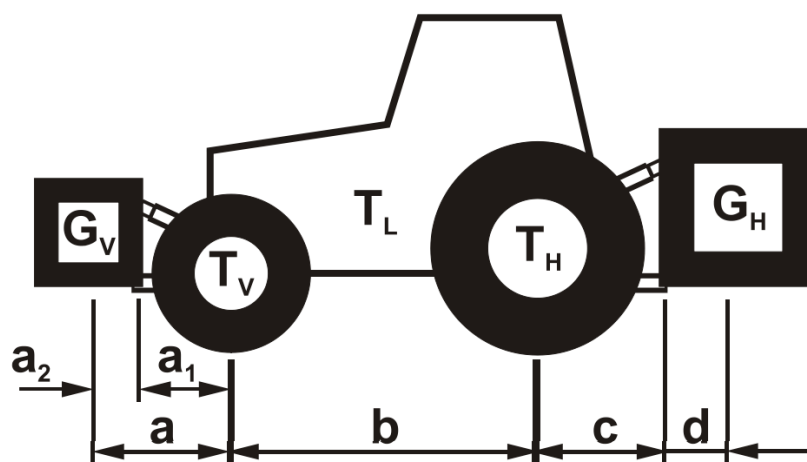


Fig. 1 Tractor parameters required for calculations

To display the dependencies, the following notations are introduced (Fig. 1):

T_L [κz] tractor's own weight,

T_V [κz] Front axle load with unloaded tractor,

T_H [κz] Rear axle load with unloaded tractor,

They are taken from the tractor's "Operation manual" or the vehicle's license plate

G_H [κz] Total weight of the rear mounted machine

G_V [κz] Total weight of the front-mounted machine or front weight

They are taken from the technical data of the front attachment or front weight machine

a [m] The distance between the center of gravity of a machine with front suspension or front weight and average front axle (sum $a_1 + a_2$) are taken from technical data tractor and machine with front suspension or front weight or measured

a_1 [m] Distance middle front axle to the middle of the connection of the lower lifting rod is taken from the "Operation manual" of the tractor or measured

a_2 [m] Distance from the middle point of connection of the lower lifting rods to the center of gravity of a machine with front suspension or front weight (distance between the points of gravity) is taken from the technical data of the tractor and the machine with front suspension or front weight or is measured

b [m] Distance between the wheels of the tractor, taken from the "Operation manual" of the tractor or vehicle plate or measured

c [m] Distance between the middle of the rear axle and the middle of the connection of the lower lifting rods, taken from the "Operation manual" of the tractor or vehicle plate or measured

d [m] Distance between the middle of the connection point of the lower connecting rods and the center of gravity of the rear-mounted machine or rear weight (distance from the center of gravity) is taken from the technical data of the machine

Commissioning

Calculation of the required minimum weight on the front axle $G_V \min$ to guarantee the steering of the tractor.

$$G_V \min = (G_H \cdot (c + d) - T_V \cdot b + 0,2 \cdot T_L \cdot b) / (a + b)$$

The calculated actual numerical value of the obtained minimum balancing $G_V \min$ is compared with the permissible value according to the "Operation Manual" of the tractor required on the front side of the tractor. It is necessary that the calculated actual numerical value of the obtained minimum balancing $G_V \min$ should be less than or equal to the permissible value.

Calculation of the actual load on the front axle of the tractor $T_V tat$

$$T_V tat = (G_V \cdot (a + b) + T_V \cdot b - G_H \cdot (c + d)) / b$$

The calculated actual value of the front axle load $T_V tat$ is compared with the permissible front axle load of the tractor specified in the tractor's "Operation manual". It is necessary that the calculated actual value of the load on the front axle is less than or equal to the value of the permissible load on the front axle of the tractor

Calculation of the actual total weight of the tractor and machine combination

$$G tat = G_V + T_L + G_H$$

The calculated actual gross weight $G tat$ is compared with the permissible gross weight of the tractor specified in the tractor's "Operating manual"

Calculation of the actual load on the rear axle of the tractor $T_H tat$

$$T_H tat = G tat - T_V tat$$

The calculated value for the actual rear axle load is compared with the permissible rear axle load of the tractor specified in the tractor's "Operation Manual". The calculated value for the actual rear axle load must be less than or equal to the specified permissible rear axle load of the tractor.

Tire load capacity

The load capacity of the front tires is determined by comparing the calculated actual value of the load on the front axle $T_V tat$ with twice the value (two wheels) of the permissible load capacity of the wheels (taken from the documentation of the manufacturer of the front tires). The calculated actual value of the load on the front axle $T_V tat$ must be less than or equal to twice the value of the permissible load capacity of the tires.

The load capacity of the rear tires is determined by comparing the calculated actual value of the load on the rear axle of the tractor $T_H tat$ with the doubled (two wheels) permissible value of the load capacity of the tires (taken from the documentation of the manufacturer of the rear tires). The calculated actual value of the rear axle load $T_V tat$ must be less than or equal to twice the value of the permissible load capacity of the tires.

It is important that all actual, calculated values are less than or equal ($\leq$) to the permissible values taken from the tractor's certificate: the permissible values for the total weight of the tractor, the load on the axles and the bearing capacity of the tires.

Possible occupational safety risks

Risk of crushing, shearing, catching, dragging and impact due to insufficient stability, as well as insufficient maneuverability and braking ability of the tractor!

It is forbidden to connect the machine to the tractor included in the calculations in the cases when

- one of the actual calculated values is greater than the allowable value.
- a front weight is placed on the tractor (if necessary) for the required minimum front balancing ($G_V min$).
- the set weight of the tractor at the front or the weight of the machine when the load on even one of the tractor axles is exceeded.

• Special cases:

o if the weight of the front machine superstructure (G_V) does not reach the required minimum front ballast ($G_V min$), you must place additional weights on the front machine superstructure!

o if the weight of the machine's rear superstructure (G_H) does not reach the required minimum rear ballast ($G_H min$), you must place additional weights on the machine's rear superstructure!

Conclusions

1. Machine-tractor units with mounted machines are the predominant part of the majority of the machines working in agriculture.

2. When aggregating tractors with mounted machines, all actual calculated values are required to be less than or equal ($\leq$) to the permissible values for the tractor, such as: the permissible values for the total weight of the tractor, the load on the axles and the bearing capacity of the tires. In case of discrepancy, they are corrected with the necessary weights to ensure safe and efficient work.

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14. Harry L. Field and John B. Solie, Introduction to Agricultural Engineering Technology, A Problem Solving Approach, Third Edition, Oklahoma State University, Stillwater, OK, USA Soil Tillage in Agroecosystems

Assessment of machines in reliability test

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Summary: The necessity of using the apparatus of mathematical statistics to obtain high reliability of the results of the evaluation of the reliability indicators of agricultural machinery in comparative tests is justified.

Two models of plant protection machines have been tested and the main numerical characteristics of the indicator production till failure of the failure-free feature have been obtained.

The application of the Student's criterion for proving the statistical significance of the difference in the tested reliability indicator is justified.

Keywords: machines, testing methodology, agricultural machinery, parameters, criteria, test plan, numerical characteristics, reliability, refusal

When testing agricultural machinery for reliability, as well as for determining all quantitative and qualitative parameters, it is necessary to use the mathematical statistics apparatus. It is best suited for making science-based decisions when determining the best machine or machine model for a given parameter. For a reliable estimate, it is not sufficient to use only the estimate of the average value of the test parameter, since the parameter is a random variable. Statistical criteria should be used to determine the significance of the difference in the mean scores. There are two sets of criteria for proving the statistical significance of the difference: parametric and non-parametric criteria. The most applicable of the group of parametric criteria is the Student's criterion, and the group of nonparametric criteria is the Man-Whitney criterion, [2-5].

The purpose of the study is to compare two models of plant protection machines against the failure free operation of reliability indicator.

The test is carried out in accordance with the experimental testing methodology [1] according to the plan [N =! RT], where R-means a plan in which the failed objects are replaced with new or repaired ones, and the T-test is carried out until the moment T.

We choose this test plan because we cannot test a large number of sites. At one site / N = 1 / we perform the test up to the moment T / the determined number of hours or area / and when a failure is detected in the machine, it is removed and the test continues until the next failure and so until the moment T occurs.

Two models of plant protection machinery from different manufacturers are subject to testing, and the results of the reliability test are given in Table 1.

Table 1. Numerical characteristics of the production-to-failure indicator of two models of plant protection machines

Dependencies for determining numerical characteristics	plant protection machines	
	Brand/ Model 1	Brand/ Model 2
$\vec{X} = \sum_{i=1}^n X_i$	$\vec{X}_1 = 45,1 \text{ h}$	$\vec{X}_2 = 62,8 \text{ h}$
$S = \sqrt{\sum_{i=1}^n (X_i - \vec{X}) / (n-1)}$	$S_1 = 19,8 \text{ h}$	$S_2 = 25,4 \text{ h}$
n	$n_1 = 36$	$n_2 = 36$

Означения: $\vec{X}$ — estimation of the average value of the measured parameter of the machine; X_i — the i th value of the parameter; S_i — estimation of the root mean square deviation of the machine parameter values; n — the number of machines tested or the measured values of the measured parameter of the machine.

As a result of the testing of the two models of plant protection machines, we find that the production up to failure of model 2 is higher than that of model 1. Only on this numerical characteristic of the measured indicator of the reliability of the machines / production up to failure / cannot to decide: which of the two models of plant protection machines has a higher level of trouble-

free operation. Therefore, we also determine the numerical characteristic - standard deviation and apply the Student's criterion for proving the statistical significance of the differences in the values of the average production up to failure of the two models of plant protection machines. Therefore, we are in the situation shown in Figure 1.

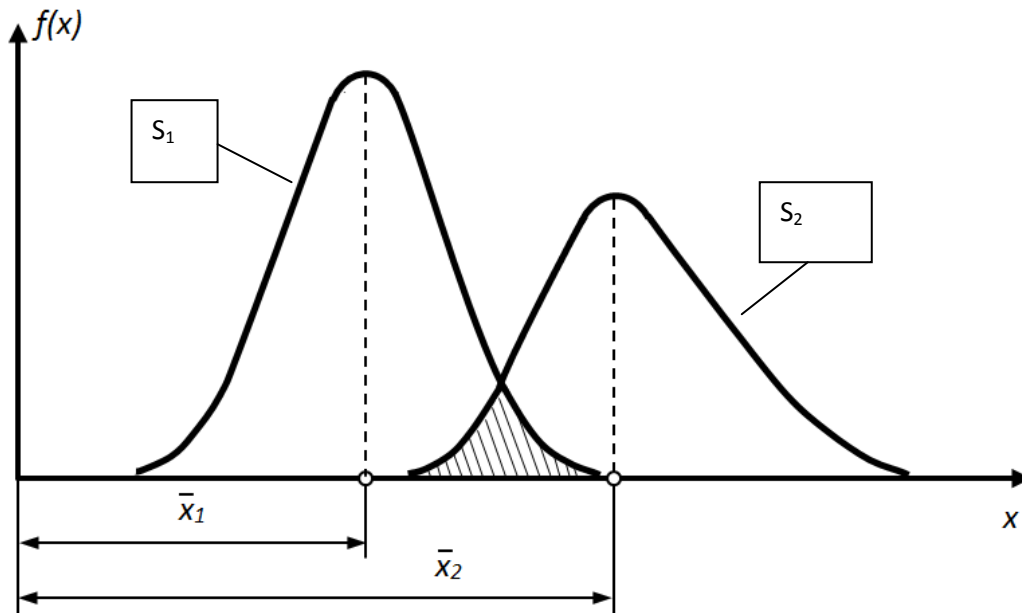


Figure 1: Densities of the distribution of work until failure of the two models of plant protection machines tested

In this situation / figure 1/, in order to decide which of the machines as a result of the reliability test has a better performance of the failure-to-build indicator, we have to apply the criterion for the statistical significance of the differences in the numerical characteristics of the performance-to-failure indicator.

The procedure for applying the Student test is as follows:

1. Determination of pooled dispersion:

$$D = \frac{1}{2}(S_1^2 + S_2^2) = 518,6$$

2. Determination of the calculated value of the Student's criterion for dependency:

$$t_{\text{ИЗЧ}} = \frac{|\bar{X}_1 - \bar{X}_2|}{\sqrt{\frac{D}{n_1} + \frac{D}{n_2}}} = 3,297 \approx 3,30$$

3. Determining the degrees of freedom and choosing the confidence probability for deciding on the statistical significance of the differences in the estimates of the reliability-to-failure indicator characteristic:

$$t_{\text{табл}} = t_{\alpha; \nu} = ?$$

The degrees of freedom are determined by the dependence of: $\nu = 2(n-1) = 70$;

and the confidence probability is assumed $\alpha = 0,01$ or $\alpha = 0,05$. We also accept 0.01 in the table of values of the Student's criterion for $\alpha = 0,01$ and $\nu = 2(n-1) = 70$;

we report. $t_{0,01;70} = 2,618$.

From here, comparing the calculated value of the Student's criterion / 3.30 / with its tabular value / 2.618 / we find that $3.30 > 2.618$, therefore the differences in the estimation of the average value of the two models' production are statistically significant, ie. the plant protection machine model 2 has a higher performance of the failure-to-failure indicator, / figure 2/.

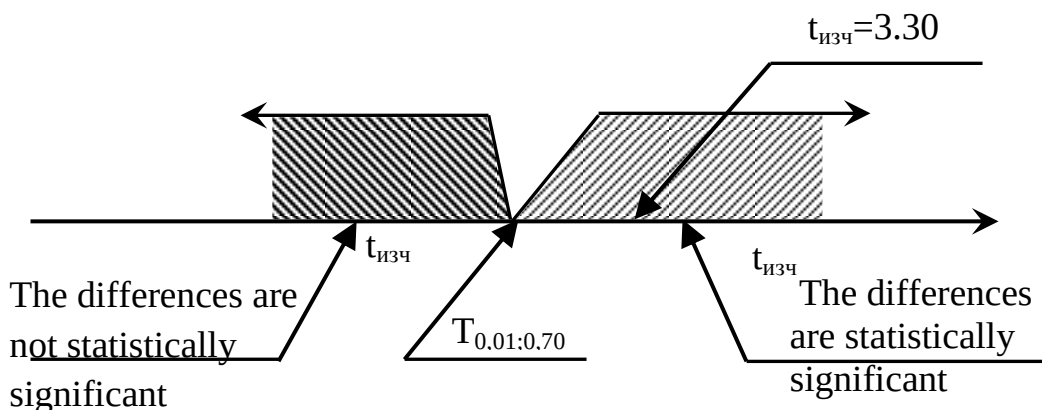


Figure 2: Graphical representation of the essence of the Student's criterion for deciding the statistical significance of the tested machine parameters.

Main conclusions:

1. Two models of plant protection machines have been tested and the main numerical characteristics of the indicator production till failure of the characteristic failure-free operation, have been determined .
2. The application of the Student's criterion for proving the statistical significance of the difference in the tested reliability indicator is justified.
3. It has been proven that the Model 2 machine is better in performance till failure than the Model 1 machine .

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Trial model of a combined machine for inter-row tillage in perennial crops

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Summary: At the Institute of Soil Science, Agrotechnologies and Plant Protection - Sofia (IPAZR - Sofia) an experimental model of a machine for combined soil treatment in permanent plantations has been developed. The machine is designed to work using technology without turning the soil layer and at the same time at a sufficient depth for fruit plantations. Tests were conducted in laboratory and road conditions to verify the capabilities of the structure. Deficiencies have been identified, as a result of which the work must continue.

KEY WORDS: TILLAGE, COMBINED MACHINE, PILOT PLANT

Introduction

The prototype of a combined machine for inter-row treatment of perennial crops is designed to investigate the capabilities of the structure to perform operations to maintain the soil surface in an optimal condition depending on the requirements of the crop. The trial sample of a combined inter-row tillage machine is made to check the technical characteristics in the subsequent examination of the sample so made.

The purpose of making and researching the experimental model of a combined machine for inter-row tillage is to determine the possibilities for its use in agriculture, and the quality of its work.

Technical characteristics

Description of the construction

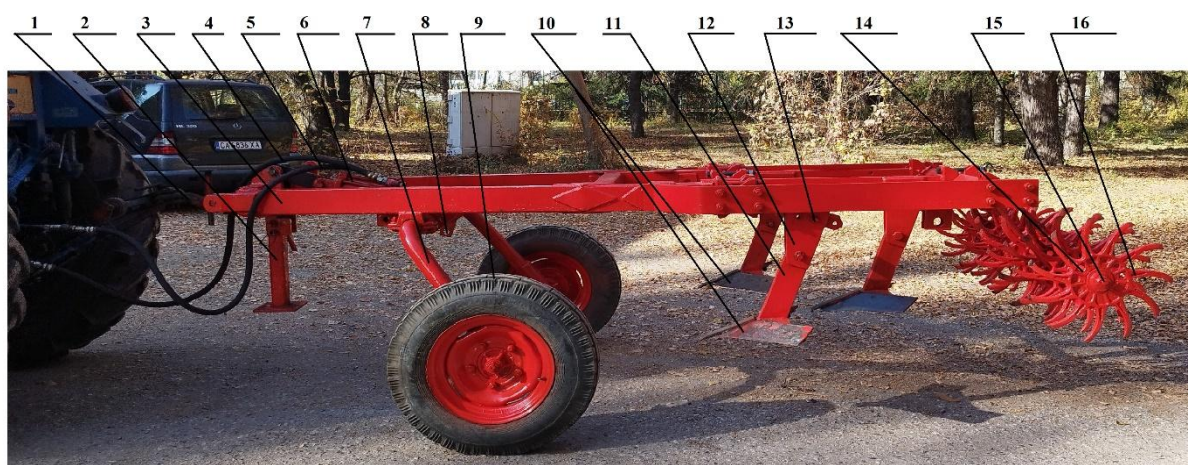


Fig. 1 Experimental model of a combined machine for inter-row treatment of perennial crops, side view



Fig.2. Trial model of combined machine for inter-row cultivation of perennial crops, rear view

The test specimen fig. 1 and fig.2. consists of the following main units: frame 3, chassis 7, towing device 1, working bodies for loosening the soil layer 10, working bodies for crushing lumps and plant residues 16, hydraulic elements 4,5,6, regulating mechanisms. The frame consists of steel

profiles, a welding structure on which the fastening elements of the working bodies 12, the towing device 1, the running system 7, the adjustment mechanisms, the mechanisms for bringing them into transport and working position 4,5,6, the safety mechanisms to ensure safe movement are located through a fixed transport position 8. If necessary to move the machine on the republican road network, it must be equipped with light signaling and other devices ensuring safe road traffic in accordance with the law on road traffic and the regulations for its application. Each of the loosening working bodies is attached to the frame by means of a ladder 11, it is provided with safety mechanisms 13 when

overloading the working body to prevent its destruction. They are located in two rows to prevent jamming between the working bodies with soil and plant residues. The type and number of working bodies is determined depending on the required working width on which the machine will work. They can be unilateral or bilateral. Usually, the one-sided ones are placed at the end of the treated strip and provide the protective zone next to the treated plants.

The machine is equipped with second toothed - rotary working bodies 16. The toothed rotary working bodies for crushing the lumps are rotary hoes, they rotate during the progressive movement of the machine and therefore are mounted on consoles and bearing bodies to the frame of the machine 14. They consist of toothed discs arranged on a rotating axis and separated by spacer bushings. The axle 15 bears on the mounting brackets of the frame 16. For a visual representation, a rear view of the machine is given in fig. 2. If necessary, it can be equipped with drum working bodies consisting of grid drums on which the crushing rails are located. Drums can also be one or more. Each drum also bears in bearing brackets attached to the machine frame. It consists of

an axle, spokes, crushing rails. The drums can be mounted to the frame by means of parallelogram mechanisms for better work, copying of the terrain and better crushing of lumps.

Transport and transport position

Bringing the machine into working and transport position is carried out by means of a power cylinder 6 connected to the hydraulic system of the tractor by means of pipelines 4 and 5. The transport position of the machine is presented in fig. 3. After that, it must be secured against lowering by means of a safety mechanism 8, in case of a possible damage to the hydraulic system of the tractor, the machine will be secured against an arbitrary transition to another position. Before separating from the tractor, the machine must be lowered onto stand 2. Stand 2 can be retracted for transport and operation by turning 90 degrees back and

Over long distances, the machine is transported by means of a motor vehicle, and the loading and unloading activities are carried out with lifting mechanisms or on a ramp on which the tractor pulling the machine approaches in reverse and separates the machine when it is on the transport vehicle.

Technological process

The technological process takes place in the following sequence: When the unit moves, the machine pulled by the tractor gradually moves and different types of working bodies perform different work. The loosening working bodies are driven into the soil and cut, lift and partially move the soil layers, cut weeds and plant residues at the depth to which the machine is pre-set.



Fig. 3. Trial sample of a combined machine for inter-row processing of perennials in transport position

fixing with a pin.

Crushing rotary hoes, due to the forward movement on one side and the friction in the soil and the forces of the earth's gravity, perform a complex movement, a rotary movement relative to the machine frame and a forward movement relative to the field. The trajectory of each of the teeth of the rotary hoe describes the trajectory of a complex tracheid. As a result, the teeth sink into the soil and crush the

clods, bring the weeds to the surface of the soil and help to break their bonds with the soil and this leads to their destruction. The drum working units, like the toothed rotary working units, rotate around their axes and break up the lumps and plant residues and weeds through the working rails.

Technical specification

№ per lines	Parameters	Data, Values	Measuring units
1	Machine type	Attached	
2	Dimensions		mm
2.1	Length	4100	mm
2.2	Width	1900	mm
2.3	Height	900	mm
3	Mass	950	kg
4	Working width		mm
4.1	On the machine	1850	mm
4.2	On a working body	620	mm
5	Aggregation	1,4, 2, 3 Depending on the depth of cultivation and soil resistance.	Tractor class
6	Movement speed	2 - 20	km/h
6.1	Working	2-10 under the conditions as point 5	km/h
6.2	Transportation	until 20	km/h
7	Processing depth	up to 500 under the conditions as point 5	mm
8	Staff	1 mechanic	number
9	Storage area	8	m ²

10	Ground clearance	300	mm
11	Machine base	1600	mm
12	Transmission	Wheel running system	type
12.1	Wheel type	pneumatic	Type
12.2	Quantity of wheels	2	number
12.3	Tire size	170-406 600-16 FOCT 7463-80	tsol
12.4	Tire pressure	3	kg/sm ²
12.5	Track	1800	mm
13	Productivity	0,2-1,4 under the conditions as point 5	ha/h

The developed experimental model of a machine for soil treatment in permanent plantations should be improved and the problems discovered during the testing process should be eliminated.

Due to the heavy weight of the structure, bringing it into transport and working position through the hydraulic system of the tractor is accompanied by vibrations. When the running system of the machine is brought into the transport position, the weight reacts, which causes the safety valves in the hydraulic distributor of the tractor system to operate, and as a result, the hydraulic hinged system begins to lift. The two hydraulic cylinders of the machine and the tractor begin to affect each other and the lifting of the tractor hitch tilts the rear of the machine down, making it difficult to get into the transport position as well. This shortcoming can be solved in subsequent research by replacing the machine's hydraulic cylinder with a longer stroke.

Conclusions

1. A pilot model of a combined machine for tillage in permanent plantations has been developed and tested. The in-service inspection showed an acceptable quality of row spacing treatment. To increase it, optimization of the operating mode parameters is required.

2. The identified problems in the operation of the hydraulic system of the machine necessitate a partial change of the design, type and location of the hydraulic cylinders.

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Neglected and underutilized crop species a path to improving nutritional security and diversification of agriculture

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Abstract: *Korça region is characterised by diverse agro-ecology and it is considered as one of the richest crop genetic resource centres for food and agriculture in Albania, but not all this richness has a continuity on cultivation and usage. Many of these species are well adapted to specific regions, to various environmental stresses and have often developed their unique characteristics, good resistance to abiotic and biotic factors common diseases and pests. They have a high potential for providing food, and nutritional security to support local food system transformation and contribute to the diversity and stability of agro-ecosystems and the diversification of agriculture. As a result, some of them are endangered, and to be lost in the near future. Encourages of their cultivation can provide a promising approach towards ensuring substantial household security and the diversification of agriculture. In his paper are indicated at least 31 crop species that are neglected or underutilized in Korça region, which can be included as future smart foods, and may contribute on diversification of food and cultivated crops.*

KEYWORDS: NEGLECTED CROP, UNDERUTILIZED CROP, BIODIVERSITY, FUTURE SMART FOODS.

1. Introduction

The genetic resources in agriculture, as part of humanity cultural heritage, are essential for the sustainable development of agricultural production, food security and adaptation to the climate change, as well as for the socio-economic development and welfare of rural areas. The sustainable conservation and utilization of plant genetic diversity are important means of achieving food security and more sustainable agriculture. Genetic diversity is a key element in farmers' livelihood strategies, particularly in areas with high ecological, climatic and economic stresses and risks. According to Wydra (2012), it is a crucial pre-requisite for sustainable agricultural production in a healthy environment is the conservation of agrobiodiversity at all scales and across all spheres.

Actually, the need for safeguarding plant genetic diversity and minimizing genetic erosion is more pressing than ever. Serious and much closer attention must be paid to the conservation and use of plant genetic resources for food and agriculture (PGRFA), including increasing the value and contribution of neglected and underutilized species to food security and sustainable livelihoods (Ghosh, 2012). PGRFA can and will play an important role in meeting the challenges of local, regional and global food security. They allow us to optimize crops according to our needs and they are an integral component in efforts to reduce agricultural pressure (chemical inputs, etc.) on the environment and to adapt to changing climate and ever evolving pests and diseases (Marino, 2012).

The genetic diversity of neglected and underutilized crop species (NUS) and landraces of major crops constitutes a very important part of agricultural biodiversity but it is in rapid decline. The loss of agricultural biodiversity and NUS, as part of it, is caused by a complex group of economic, social and demographic factors, including agricultural and food systems that focus on a very limited number of crops. The alarming decline of NUS genetic resources and the traditional knowledge associated with them has far-reaching implications for agriculture.

NUS are those species with under-exploited potential for contributing to food security, health, income generation, and environmental services (Will, 2008). Underutilised crops are plant genetic resources with limited current use and potential to diversify and improve cropping systems and supply chains in a given context. They represent an important component of agro-biodiversity with potential to contribute to climate change adaptation, food security and sovereignty of marginal communities and rural areas. Terms such as underutilized, neglected, orphan, abandoned, lost, underused, local, minor, traditional, forgotten, alternative, niche crops, promising, underdeveloped, crops of the future or future smart foods (Padulosi & Hoeschle-Zeledon, 2004; Will, 2008) and other terms as minor, "poor man's crops" or "orphan crops" (Singh & Dhatt, 2021) are often used interchangeably as synonyms to define neglect and underutilized species (Padulosi & Hoeschle-Zeledon, 2004; Will, 2008), which have been marginalized by specialized modern agricultural production systems. Owing to the many synonyms used when referring to NUS, perhaps the best way

to understand what the term really means is to identify their key features underutilized species have in common and show how these relate to our lives (Padulosi & Hoeschle-Zeledon, 2004). Underutilized species are: important in local consumption and production systems, ignored by policy makers and excluded from research and development agendas, highly adapted to agro-ecological niches and marginal areas, resilient to climate change, represented by ecotypes or landraces, most underutilized, cultivated and utilized drawing on indigenous knowledge, hardly represented in ex situ gene banks (Padulosi & Hoeschle-Zeledon, 2004; IFAD, 2021).

NUS are crops that have left at the margins of research and development. The word 'neglected' underlines the low level of research investments made on these species when compared with mainstream commodity crops and 'underutilized' alludes to their untapped livelihood potentials (IFAD, 2021). NUS include wild, semi or fully domesticated plants from various food groups (cereals, vegetables, legumes, roots and tubers, fruits, spices) and are an integral part of local cultures and food traditions (IFAD, 2021). The NUS commercial potential and the knowledge and technologies on how to utilize this potential in a competitive environment are ignored, and as consequence, their potential to contribute to agrobiodiversity conservation, food security, nutrition and health, climate change adaptation, as well as poverty alleviation, is not tapped (Will, 2008).

Korça region is characterised by diverse agro-ecology and it is considered as one of the richest plant genetic resources and NUS for food and agriculture in Albania. Many of these species are well adapted to specific regions, to various environmental stresses and have good resistance to common diseases and pests. Nevertheless, NUS' cultivation and use is declining from time to time and nowadays have a limited attention on the diversity and conservation of those genetic resources. This paper briefly discusses opportunities for a better and more sustainable management of plants, which opens up new possibilities for enhancing the conservation and potential use of landraces, underutilized and neglected species in Korça region, which can be included and used as future smart foods, and may contribute on diversification of food and cultivated crops.

2. Methodology

This paper is a preliminary study focused on identifying opportunities for promoting neglected and underutilized crops in Korça Region, in Albania and provides a specific analysis on this region. The paper was prepared based on a literature review, but also includes special attention to NUS in agricultural traditional systems and local varieties and landraces plant where significant agro biodiversity is found. Data were collected during expeditions from the different villages, direct observation and individual interviews. Field visits were carried out to see some of the species under cultivation and pictures for documentation were taken. The field investigations were carried out between May 2020 and August

2022. In addition, literature research were also developed for better documentation of the NUS recorded. A preliminary summary list of neglected and underutilized plant species, excluding fruit tree crops, was carried out based on literature review, analysis of Korça' community seed bank accessions, discussions with different farmers, researchers at Korça University and in agricultural research stations. The list included 31 species (Tab. 1). Crop identification includes also landraces of maize (*Zea mays* L.) and common bean (*Phaseolus vulgaris* L.).

3. Results and Discussion

The study revealed that no document, publication, or project has developed a list of neglected and underutilized crop species for both Korça Region and Albania. Based on the gathered information, there are at least 31 crop species, listed as neglected and underutilized in Korça (Tab.1).

Some neglected and underutilized crop species have many important medicinal properties beside their nutritional value and can be used as nutraceutical or functional food, such as *Armoracia rusticana*, *Trigonella foenum-graecum* and *T. caerulea*, *Portulaca oleracea*, *Panicum miliaceum*, *Lathyrus sativus*, *Sinapis arvensis* etc.

For example, horseradish (*Armoracia rusticana* Gaertn., Mey. & Scherb.) is a source of many biologically active compounds as glucosinolates, phenolics, flavonoids, phytoncides, essential oils, enzymes and other constituents including, vitamin C and B1, minerals (iron, potassium, calcium and magnesium) as well as kaempferol and quercetin (Stillo *et al.*, 2018). The average content of vitamin C in horseradish can be almost three times higher than in citrus fruits (Rivelli *et al.*, 2017). The richness in phytochemicals has encouraged the use of its roots and leaves in functional food and medicine for human health (Agneta *et al.*, 2013; Stillo *et al.*, 2018). In Devoll area in Korça region horseradish is used to prepare pickled vegetables and fruits (Stillo *et al.*, 2018).

Grass pea (*Lathyrus sativus* L.) produces seeds with very high protein concentration of up to 34.6%, which is higher than in chickpea, fava bean, or lupine (Lambein *et al.*, 2019; Arslan *et al.*, 2022). It is one of the most affordable and the largest source of protein next to soybean. Grass pea is the only known dietary source of essential amino acid L-homoarginine (Ramya *et al.*, 2022; Lambein *et al.*, 2019), that may influence nitric oxide metabolism, endothelial function, insulin secretion, and inhibit platelet aggregation. Grass pea provides benefits in cardiovascular diseases treatments, including atherosclerosis, type 2 diabetes mellitus, and stroke (Ekua *et al.*, 2019) and is useful to treat hypoxia - Alzheimer's disease and other memory-related disorders (Ramya *et al.*, 2022). Therefore, as nutraceutical, grass pea is an excellent example of a potential "functional food" (Lambein *et al.*, 2019; Llorent-Martínez *et al.*, 2018). Currently, in Albania this culture is heavily marginalized and reduced to a very small area. It was cultivated years ago on in the southeastern area of the country, in Korça region, as a pulse that can be used for both food and feed, especially on marginal cropland with poor soils and into the rain-fed farming systems. The cultivated area in this region is estimated in the only few ha. The varieties sown are landraces maintained by traditional farming practices within the traditional agro-ecosystem that are adapted to local agro-climatic conditions. As world demand for legume protein increases, the rusticity of grass pea recalls its potential for cropping systems in marginal environments (Rubiales *et al.*, 2020) like those of highland conditions on Korça region.

Fenugreek seeds (*Trigonella foenum-graecum* L.) are rich in protein, lipids and mucilaginous fibre, variety metabolites, including alkaloids, saponins, sterols, flavonoids, coumarins and tannins compounds. Other constituents as vitamins (nicotinic acid, B1, C, A, and D) and minerals such as iron, phosphate, calcium and zinc are present (Icka & Damo, 2018). According to WHO (2007), in traditional medicine fenugreek is used as aphrodisiac, carminative, diuretic, emollient, galactagogue and tonic as well as a treatment of abdominal colic, bronchitis, diarrhoea, eczema, gout, indigestion, dropsy, fever, impotence, chronic cough, liver disorders, wounds and the common cold. Whereas in Arrëza village

of Devoll area, the ground fenugreek seeds are often used to flavour sweets, to give special flavour, especially in baklava. In addition, the seeds are used to make tea, to treatment of fever, cough, and the common cold (Icka & Damo, 2018).

Purslane (*Portulaca oleracea* L.) contains high level of nutrients and biologically active compounds (Rashed *et al.*, 2004; Di Cagno *et al.*, 2019) and has very important effects on human health and nutrition. It contains approximately 30 different biological activities and over 60 medicinal indications concerning the plant (Bossi *et al.*, 2009; Damo *et al.*, 2011). Purslane is considered as the richest vegetable source of ω -3 fatty acids, especially α -linolenic and γ -linolenic acids (Bianco *et al.*, 2001; Palaniswamy *et al.*, 2004; Damo *et al.*, 2011; Mishra *et al.*, 2020). It has been reported that it contains five times higher ω -3 fatty acids than spinach (Mishra *et al.*, 2020). Purslane is identified as a rich source of antioxidant vitamins such as ascorbic acid, α -tocopherol, β -carotene and glutathione, as well as amino acids isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine and valine (Peksel *et al.*, 2006; Damo *et al.*, 2021). Purslane also provides a source of alkaloids, coumarins, flavonoids, anthraquinone glycosides and betacyanin (Palaniswamy *et al.*, 2004; Peksel *et al.*, 2006; Damo *et al.*, 2011) and potassium, magnesium, sodium, and sulphur (Bossi *et al.*, 2009; Damo *et al.*, 2011). Purslane is considered a "medicinal food" (Bossi *et al.*, 2009; Damo *et al.*, 2011), a "power food" of the future because of its high nutritional and antioxidant properties (Gonnella *et al.*, 2005; Peksel *et al.*, 2006; Damo *et al.*, 2011). It has gained attention as a functional food (Di Cagno *et al.*, 2019; Kumar *et al.*, 2021; Souza *et al.*, 2022) and as an important nutraceutical food (Kumar *et al.*, 2021) due to the chemical composition of this plant regarding bioactive compounds.

Table 1. List of neglected and underutilized species

No	Latin plant name	Common plant name
1	<i>Armoracia rusticana</i> Gaertn., C.A.Mey.&Scherb.	Horseradish
2	<i>Trigonella foenum-graecum</i> L.	Fenugreek
3	<i>Trigonella caerulea</i> (L.) Ser.	Blue fenugreek
4	<i>Atriplex hortensis</i> L.	Garden orache
5	<i>Portulaca oleracea</i> L.	Common purslane
6	<i>Cicer arietinum</i> L.	Chickpea
7	<i>Lens culinaris</i> L.	Lentil
8	<i>Lathyrus sativus</i> L.	Grass pea
9	<i>Lathyrus tuberosus</i> L.	Tuberous pea
10	<i>Vicia faba</i> L.	Faba bean
11	<i>Vicia ervilia</i> L.	Bitter vetch
12	<i>Vicia sativa</i> L.	Common vetch
13	<i>Glycine max</i> (L.) Merr.	Soybean
14	<i>Sorghum bicolor</i> L.	Broomcorn
15	<i>Panicum miliaceum</i> L.	Proso millet
16	<i>Rumex acetosella</i> L.	Sorrel
17	<i>Sinapis arvensis</i> L.	Wild mustard
18	<i>Helianthus tuberosum</i> L.	Jerusalem Artichoke
19	<i>Triticum monococcum</i> ssp. <i>monococcum</i> L.	Einkorn
21	<i>Triticum turgidum</i> L.	Durum wheat
22	<i>Chenopodium bonus-henricus</i> L.	Perennial goosefoot
23	<i>Coriandrum sativum</i> L.	Coriander
24	<i>Anethum graveolens</i> L.	Dill
25	<i>Helianthus annuus</i> L.	Sunflower
26	<i>Tanacetum balsamita</i> L.	Costmary
27	<i>Chenopodium album</i> L.	Fat hen
28	<i>Vigna unguiculata</i> (L.) Walp	Cowpea
29	<i>Lupinus albus</i> L.	Field lupine
30	<i>Avena sativa</i> L.	Oat
31	<i>Fagopyrum esculentum</i> Moench.	Buckwheat

Broomcorn/common or proso millet (*Panicum miliaceum* L.) is nutritionally comparable to major cereals and serve as good source of protein, micronutrients and phytochemicals. It has recently received increasing interest due to its nutraceutical traits (Calamai *et al.*, 2020).

Despite their huge nutritional, economic, and medicinal importance, fenugreek, horseradish, purslane and broomcorn millet remained neglected and underused plant to date in Korça region and Albania. They should considered for a sustainable food security in the future. NUS are good sources of micronutrients, protein, energy and fibre, which would contribute to food and nutrition security, therefore they may be prioritized for consideration as Future Smart Food (FSF). According to FAO (2018), FSFs are defined as neglected and underutilized species that are nutrient dense, climate resilient, economically viable, and locally available or adaptable. Pulses (dry beans, field pea, grass pea, chickpea, cowpea, lupine, common bean, fava beans, lentil and others) may be prioritized as FSFs in Albania. They contain many ingredients that are important for a healthy diet and that can help to reduce the risk of developing chronic non-communicable diseases. For example, chickpea, in comparison with polished white rice, contains three times more protein, four times more dietary fibre, four times more iron and 70 times more folate, though the energy level is similar in both crops. Lupine contains five times more protein, eight times more dietary fibre, four times more iron and 44 times more folate than rice (Li & Siddique, 2020).

Surveys conducted showed that cultivation, utilization and traditional knowledge related to NUS are decreasing although they play, or have great potential to play, an important role in diversifying the diets, in improving the nutrition, in strengthen food and nutrition security and resilience in the face of climate change. For this reason, is necessary to take initiatives to raise awareness about the importance of NUS for food and nutrition security, and to make them more available and accessible for farmers, and all the possible actors including researchers, developers, and producers. In this regard, according to Oxfam Novib (2018), the development of strategies focused on the long-term food preservation of key nutritional NUS is crucial.

The stress derived from water deficit is currently one of the most important problems in agriculture. Local varieties of crops can provide the adaptations required to overcome the environmental variations derived from climate change. NUS and local cultivars traditionally grown over the years should be expected to show better adaptability to the climate change effects, as they are already adapted to the hot and dry summer's characteristic of the local and regional climate. NUS harbour also specific adaptations for low-input farming, therefore, they can help face new regional agricultural challenges. For example, broomcorn millet (*Panicum miliaceum*) is one of the underutilized crops of cereal grains in Albania. It grows well under marginal conditions of soil fertility and moisture. This climate resilient crop is characterized by resistance to pests and diseases, short-growing season, and productivity under high-temperature and drought conditions in which the major cereals cannot be to provide sustainable yields (Himanshu *et al.*, 2018). The short growing cycle (3–4 months) makes this species desirable for sustainable rain-fed agriculture (Calamai *et al.*, 2020). The distinctive biological, nutritional and ecological traits makes broomcorn millet particularly attractive and as one of the most valuable crops for the world's food supply today (Kirleis, *et al.*, 2022).

To elevate the awareness on the contribution of millets for food security and nutrition and to promote its diversity, ecological benefits and nutritional value, the Food and Agriculture Organization of the United Nations (FAO) declared 2023 as the International Year of Millet.

Local varieties or landraces of crops, apart from their commercial, medicinal and cultural value, are very important for sustainable food production as they reduce the impact of production systems on the environment. Landraces of many crops are naturally adapted to specific local and regional conditions (marginal soil and climatic conditions), and can be grown with minimal external inputs. For

example, in many areas of Korça, especially in the hilly-mountainous zones, where due to non-irrigable conditions, some traditional landraces of common bean (*Phaseolus vulgaris* L.), drought-tolerant with short growth cycles ("Saçme", "Saçme e "Goskovës", "Kraçe e Vidohovës", fasule e Prespës, fasule "Përdhese" etc.) have been successfully cultivated. In addition, in such conditions, some landraces of maize (*Zea mays* L.) (Maiz of Prespa, Maiz of Sinica, etc.), have been successfully cultivated.

Biodiversity of plant species used as human food is a decisive tool for ensuring food productivity and food security not only for farmers, but also for the other consumer (Baldermann *et al.*, 2016). Agricultural diversification is key to make agro-food systems more sustainable. Consequently, numerous neglected and underutilized species offer the potential to diversify not only the human diet, but also increase food production levels, and, thus, enable more sustainable and resilient agro-food systems. Introducing these orphan species would increase the opportunity to produce nutrient-rich food as well as simultaneously enhancing the environmental capacity for future generations to supply themselves (Baldermann *et al.*, 2016).

Crop diversity, food security and climate change are closely linked in diverse and complex ways (Marino, 2012). In the context of global climate change it is expected to have a major impact on biotic and abiotic stresses in agricultural production systems and on yield and sustainability of crops, for this reason a greater crop diversity in the planting system will increase resilience to abiotic and biotic stresses. According to Ebert (2014), a wider use of neglected and undervalued crops and species would provide multiple options to build temporal and spatial heterogeneity into uniform cropping systems, thus enhancing resilience to biotic and abiotic stress factors and ultimately leading to more sustainable supply of diverse and nutritious food. The diversity of underutilized plant species, landraces and crop wild relatives, represent significant repositories of traits that could contribute to the ongoing efforts to produce food of sufficient quantity and adequate quality with minimum inputs (Ghosh, 2012). However, some of such crops are currently in first steps of attention attractor from local farmers as *Armoracia rusticana*, *Vigna unguiculata*, *Cicer arietinum*, *Lathyrus sativus* etc. The re-introduction, management and promotion of NUS is highly important for future agricultural diversification and food security as well as to increase farmer income (Schmidt *et al.*, 2008).

Unfortunately, there are no specific policies in Albania and in Korça Region regarding the utilization and protection of NUS and the attention of human and institutional capacity required for research, marketing and knowledge sharing in NUS is weak or absent. Despite the essential role of PGRFA and NUS of Albania, the level of attention given to their collection, conservation and sustainable use is insufficient. Some of the most important reasons for the status of the NUS and their relative importance are: the lack of financial supports for research oriented to the neglected crops, lack of national promotion police, low yield, young generation of farmers are mostly interested in cash crops that can provide them with a lot of money, lack of information for species with nutraceutical values. If no action will be take, to halt the rate of genetic erosion in NUS then they would inevitably lose their value, and the loss of useful genetic resources could compromise future food security.

The lack of a national strategy and programmes for the collection, conservation and sustainable use of plant genetic resources, together with the lack of funds, lack of public awareness, and limited human capacity available for dealing with PGRFA management, remain a serious and urgent issues for Albania that should be addressed in the near future (Ibraliu, 2018). To address this problem, universities/research institutes in Albania and the Korça region should undertake projects to build human and institutional capacities to increase the conservation and use of neglected and underutilized crop species, as well as studies on diversity of neglected and underutilized species of food crops.

In order to provide policy makers with more detailed and convincing economic data, it is recommended that a scientifically

well-designed socioeconomic study should be conducted on the identified species.

4. Conclusions

Korça Region has a great diversity of neglected and underutilized crop species. Thirty one NUS were identified across different crop categories. This is the first list conducted for Korça Region and Albania too. The conservation, use, management and promotion of neglected and underutilized crop species can play an important role in local diet diversify and sustainable food production system, providing valuable nutritional components and contribute to the diversity and stability of agro-ecosystems and the diversification of agriculture. Encourages of their cultivation and use can provide a promising approach towards ensuring substantial household security and the diversification of agriculture. They can also help to generate income from labour for farmers throughout the year.

Although the use and value of these plants are clearly familiar to the farmers' communities, more needs to be done to enhance knowledge. Unfortunately, NUS have never been the priority of the national and regional agricultural research system and are frequently not recognized in the context of food and nutrition policies, mainly because of lack in political and financial supports. In the long-term, for the promotion of NUS, it will be important to put in place a national and special research, involving all the possible actors. Also, there should be adopted a socio-ecological approach and policies that are consistent with their sustainable use, management and development, to make significant contributions to local economies and food security.

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Advanced Review on Soil Microbiology and Fertility of Soils

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Abstract: Soil microbiology is highly linked with the microorganisms and their particular activities regarding the growth of plants and yield while taking a part of the nitrogen cycle which is an important component in the providing of nutrients for the growth of plants. In the case of atmospheric nitrogen fixation, organic matter decomposition and releasing of some bio-chemical enzymes are the important factors regarding the growth of plants and roots. In generally, the microorganisms are categorized into a few of specific groups while considering their biological features and behaviors such as bacteria, viruses, fungus and algae. When considering the main role of microorganisms can do in the soil is the increasing of soil fertility while improving the soil structure, increasing the plant tolerance and providing of a self protection against the diseases of plants. According to the agricultural practices, the great diversity of microorganisms plays a few of important roles in the maintaining of the equilibrium of the soil and plant including the top soil which provides habitations for a large number of microbial communities.

Keywords: SOIL, MICROORGANISMS, IMPORTANCE, POSITIVE AND NEGATIVE IMPACTS, SOIL FERTILITY

1. Introduction

Soil microbiology is the scientific study of all biological features of microorganisms that reside in the soil environment as mentioned in the below.

- Bacteria
- Archaea
- Viruses
- Fungus
- Parasites
- Protozoa

This is a branch of environmental microbiology. Soil microbiology is an interdisciplinary field that is intertwined with soil biochemistry and microbial ecology. It necessitates an understanding of soil science, microbiology, and the chemistry of biological systems. Soil microbiology can be divided into two categories. The first approach examines organisms' physiology and taxonomy, whereas the second focuses on microbial activities, or the behaviors and tasks of microorganisms in soil [1-5].

Soil is a diverse ecosystem with ever-changing environmental conditions for microbial growth. Soil microorganisms are abundant and have a diverse set of metabolic activities and physiological features that are critical to the cycling of nutrients within the soil and the removal of contaminants from the soil.

The soil contains a diverse spectrum of microorganism substrates, ranging from simple sugars to the most complex compounds, such as humus. Soil also has several micro sites with variable nutrient, moisture, pH, and Eh levels across relatively short distances and over time. Soil has the greatest diversity of life as a result of its chemical and physical heterogeneity [3-9].

Microorganisms are extremely small forms of life that can exist as single cells or in colonies of cells. Individual cells of these organisms are normally visible only through a microscope. Topsoil has far more microorganisms than subsurface because food supplies are numerous. They are especially common in the rhizosphere, where sloughed-off cells and substances generated by roots provide easy food sources. These organisms are major decomposers of organic debris, but they also feed nitrogen to growing plants through fixation, detoxify dangerous compounds (toxins), suppress disease organisms, and generate products that may stimulate plant growth. Soil microorganisms have another direct impact on humans. They are the source of the majority of antibiotics used to treat diseases. Bacteria can live in almost any environment. They can be

found in animals' digestive systems, the ocean and fresh water, compost piles and soils. Although certain bacteria may survive in waterlogged soils without oxygen, the majority prefer well-aerated soils. Bacteria do better in neutral pH soils than in acidic soils [4-14].

Bacteria aid plants by boosting nutrient availability, in addition to being among the first organisms to begin degrading leftovers in the soil. Many bacteria, for example, dissolve phosphorus, making it more available to plants. Bacteria are also particularly useful in delivering nitrogen to plants, which they require in vast quantities but which is frequently low in agricultural soils. You may be wondering how soils can be nitrogen deficient while we are surrounded by it nitrogen gas makes up 78% of the air we breathe. Plants and animals, however, suffer a conundrum akin to that of the ancient mariner, who was stranded at sea without fresh water, everywhere, and not a drop to drink. Unfortunately, neither animals nor plants can consume nitrogen gas (N₂). Some bacteria, on the other hand, can take nitrogen gas from the environment and transform it into a form that plants can use to build amino acids and proteins. Nitrogen fixation is the name given to this conversion process [3-8].

Plants and animals, on the other hand, face a dilemma similar to that of the Ancient Mariner, who was stranded at sea without fresh water: "Water, water, everywhere, and not a drop to drink." Unfortunately, neither animals nor plants have the ability to ingest nitrogen gas (N₂). However, some bacteria can convert nitrogen gas from the environment into a form that plants can use to build amino acids and proteins. This conversion process is known as nitrogen fixation.

Some legumes or their derivatives, such as peas, dry beans, and soybean tofu, are consumed. Animal feed is made from soybeans, alfalfa, and clover. Clovers and hairy vetch are produced as cover crops to improve the soil with organic matter and nitrogen in preparation for the next harvest. Each year, microorganisms in an alfalfa field can repair hundreds of pounds of nitrogen per acre. The amount of nitrogen fixed by peas is substantially smaller, ranging from 30 to 50 pounds per acre. Another type of bacteria, actinomycetes, breaks down giant lignin molecules into smaller ones. Lignin is a big and complex chemical found in plant tissue, particularly stems, that most organisms find difficult to break down. Lignin also typically protects other molecules from breakdown, such as cellulose. Actinomycetes have some traits with fungus, however they are occasionally classified separately and given equal billing with bacteria and fungi [1-8].

A few of sketches of some well recognized microorganisms are shown in the following figures.

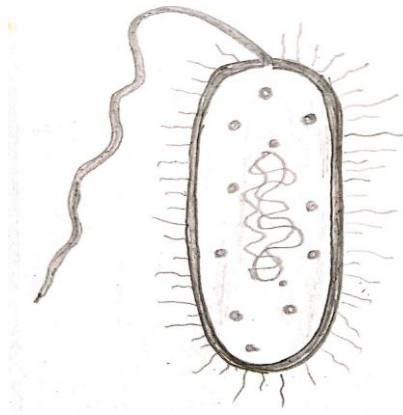


Fig. 1. A general side view of bacteria

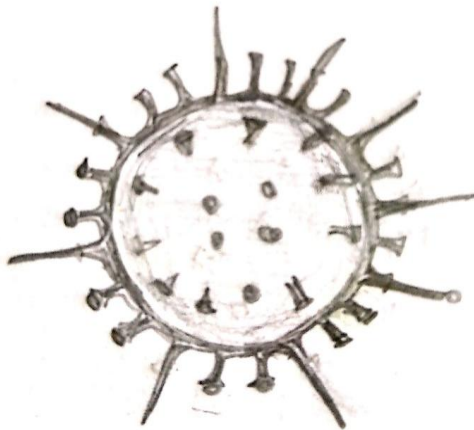


Fig. 2. A general side view of a virus

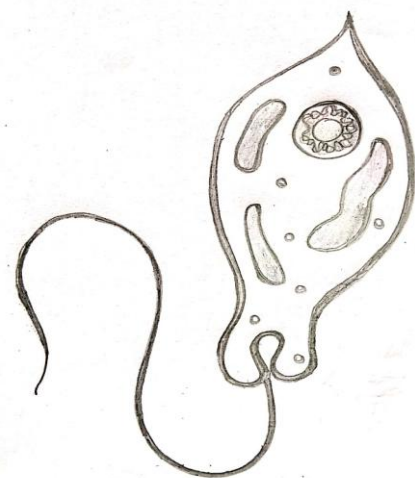


Fig. 3. A general side view of euglena

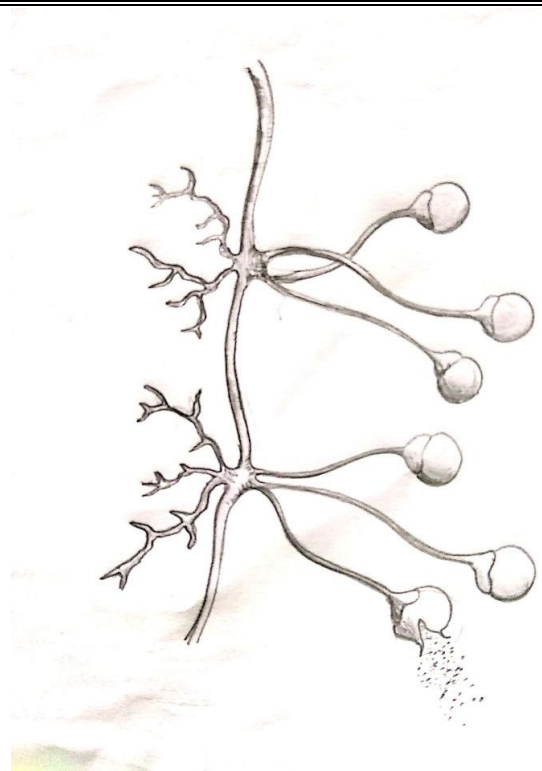


Fig. 4. A general side view of a fungus

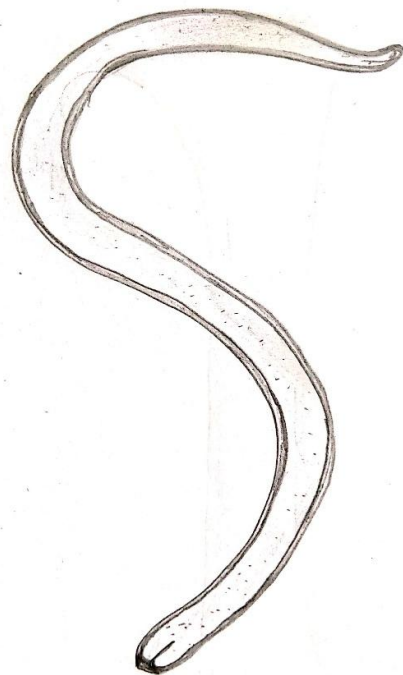


Fig. 5 A general side view of a nematode

Importance of soil microorganisms has been defined as follows.

- Decomposition of resistant components of plant and animal tissue
- Role in microbial antagonism
- Participate in humus formation
- Predator of nematodes

- Surface blooming reduces erosion losses
- Improve soil structure
- Involved soil structure
- Maintenance of biological equilibrium

2. Types and Categories of Micrograms in Soil

2.1. Bacteria

Bacteria are the most abundant and tiniest cellular creatures in soil. They are prokaryotic organisms that range in size from 0.5mm to 1mm in width and 1mm to 2mm in length. The ultra micro-bacteria can be as small as 0.3mm in diameter and have cell contents of less than 0.1 mm^3 [1-6].

Although bacteria have a variety of cell shapes, including rod, spherical, spiral, and filamentous, the most common cell shape found in soil is a short rod. Bacteria are one of the most abundant groups of microorganisms in soil, with the majority of them found in the rhizosphere. Bacteria in the rhizosphere are larger and contain more Gram-negative and denitrifying bacteria than bacteria in the bulk soil.

2.2. Fungi

Soil funguses are eukaryotic organisms that can be unicellular but are usually multi cellular. Fungi have more complex morphologies and life cycles than bacteria. Yeasts are fungi that reproduce asexually by budding. Most other fungi have filaments that are highly branched, with strands that are 2 to 30 mm in diameter and several centimeters long. Except for yeasts, which can survive in anaerobic environments by fermenting sugars into alcohol, most fungi are aerobic [1-7].

2.3. Actinomycetes

Actinomycetes are filamentous bacteria, the majority of which are Gram-positive bacteria that thrive in neutral to alkaline soils. Actinomycetes are primarily anaerobic organisms that develop colonies or vast mycelia. However, the mycelia may break off in some cases, resulting in rod- or coccid-shaped forms. Despite the fact that they are bacteria, their biomass and distinguishing characteristics have resulted in a distinct classification. Actinomycetes range in size from 0.5 to 1.5 m depending on the species [3-9].

2.4. Protozoa

Protozoa are single-celled eukaryotic microorganisms with no cell walls. They are motile heterotrophs that consume bacteria, yeasts, algae, tiny protozoa, and organic debris for nourishment. Flagellates, amoebae, and ciliates are the three types of free-living soil protozoa.

The shape, size, and distribution of these single-celled animals differ from that of some protozoan species found in land habitats such as soil [2-8].

2.5. Algae (blue-green algae)

Cyanobacteria are phototrophic bacteria that thrive in soils with access to light and water. Cyanobacteria are autotrophic eukaryotes that include free-living photosynthetic bacteria as well as endosymbiotic organisms. Blue-green algae exist as motile filaments of cells that spread out to form new colonies. Blue-green algae can be colonial or filamentous, and the filamentous forms can be heterocystous or non-heterocystous. The heterocysts are enormous, thick-walled cells that fix nitrogen under anaerobic conditions.

2.6. Viruses

Viruses are genetic elements that can reproduce independently of chromosomes but not independently of cells. Viruses are smaller than bacteria, with diameters ranging from 20 to 30 nm. Viruses are

obligate parasites of soil bacteria, fungi, insects, plants, and animals. Viruses can exist as dormant structures or particles for extended periods of time in a variety of environments. Because viruses are obligate parasites, they can be found anywhere there is life.

3. Impacts of Microorganisms in Soil

3.1. Positive Effects of Bacteria in Soil

Bacteria are an important part of the soil's biotic component since they are responsible for many physiological activities that occur in the soil. Soil bacterial communities provide a plethora of ecosystem services that have an impact on the entire functioning of the soil environment, both directly and indirectly. Many bacteria in the soil create polysaccharides or glycoprotein, which form a coating on the soil particle's surface. As a result, these chemicals function as cementing agents and strengthen soil structure.

Bacteria are engaged in the generation of many nutrients for the soil and plants as part of many biogeochemical cycles such as the nitrogen cycle and the carbon cycle. Bacteria improve soil quality, allowing new plant communities to thrive. Furthermore, bacteria are important for the enzymatic degradation of complex organic and soil substances to nutrients, as well as the release of nutrients and trace Enzymes elements from the mineral soil fraction. Bacterial populations in soil serve as markers of soil condition [2-8].

3.2. Negative Effects of Bacteria in Soil

Pathogenic bacteria in the soil may have negative impacts on crops, resulting in poor crop health, low yields, and crop loss. Some bacteria are known to disrupt the soil's biological balance, resulting in soil infertility and poor soil health. Furthermore, pathogenic bacteria found in soil can cause a variety of plant illnesses. The release of various by-products may alter soil chemical properties such as pH, cation exchange capacity, and nutrient content.

3.3. Positive Effects of Fungi in Soil

Fungi have critical roles in the soil, where they aid in nutrient cycling, water dynamics, and disease suppression, all of which contribute to soil health and crop output. Soil aggregates are stabilized by fungal hyphens, which bind soil particles together. Almost all terrestrial plants generate advantageous mycorrhizal symbioses with fungi. Mycorrhizal fungi improve plant uptake of mineral nutrients (such as phosphorus and zinc) in return for carbon molecules fixed by photosynthesis. Fungi are important organic matter decomposers in the soil, where they use nitrogen from the soil to decompose woody carbon residues. Fungi's huge size protects plants from pests, illnesses, and drought. Antibiotic substances such as penicillin and cyclosporine are also produced by fungi. Lichens are symbiotic relationships between a fungus and an alga or cyanobacterium. They are important soil colonizers with important roles in soil formation and stabilization [3-11].

3.4. Negative Effects of Fungi in Soil

Pathogenic fungi in soil cause a variety of plant diseases by penetrating plant tissue and cause a weakened, nutrient-deficient plant. Fungi, in addition to their direct effects on plants, influence plant interactions, altering the competitive balance between two species. Mycorrhiza and fungal pathogens also affect seedlings, which has a negative impact on plant population dynamics [2-10].

3.5. Positive Effects of Actinomycetes in Soil

Actinomycetes degrade the most refractory and indecomposable organic compounds, resulting in the production of various dark black to brown pigments that contribute to the dark hue of soil humus. These organisms are also in charge of the degradation of humus (resistant substance) in soil. Actinomycetes play an important role in agricultural soils because they fix carbon (via photosynthesis) and decompose it. Actinomycetes form associations with non-leguminous plants and fix N_2 , which is then available to both the host and nearby plants.

Actinomycetes are the most important group of soil microorganisms that recycle organic matter in the environment by producing hydrolytic enzymes. They have direct or indirect methods that promote plant development while enhancing nutrient and mineral availability, synthesizing plant growth regulators, and phytopathogen suppression. Many actinomycete features have the potential to be used as biocontrol agents [4-12].

3.6. Negative Effects of Actinomycetes in Soil

Actinomycetes' products may have an impact on soil microbes, resulting in decreased diversity. Plant diseases caused by pathogenic actinomycetes impair plant health and crop loss.

3.7. Positive Effects of Protozoa in Soil

Protozoans play an important role in terrestrial ecosystems by acting as bacterial consumers, resulting in the mineralization of organic soil nitrogen to create ammonium. Protozoan communities in soil can also be utilized to analyze and monitor changes in soil biotic and abiotic components, acting as soil bio indicators. Plant biomass can be increased by protozoa regardless of nutrient concentration in plant tissue. Many protozoan species feed on bacteria and other microbes, enhancing nutrient cycles and energy transfer among microorganisms, animals, and plants.

3.8. Negative Effects of Protozoa in Soil

Because most bacterial communities in soil provide food for protozoa, the presence of protozoa in soil influences bacterial diversity. Some protozoa may be damaging to the plant, reducing crop health and output.

3.9. Positive Effects of Blue-Green Algae in Soil

Cyanobacteria were among the first microorganisms to inhabit terrestrial habitats. These microorganisms are important in soil because they fix nitrogen and carbon through the synthesis of exopolysaccharides, which increase soil fertility and water retention capacity. The use of cyanobacteria as inoculants to induce bio crust formation on soil is a novel technology that restores barren, degraded areas while preventing desertification.

Because of their filamentous structure, they play important roles in increasing soil physical structure, porosity, and retaining soil moisture. In the soil, these organisms also produce mucilaginous substances and release phytohormones, vitamins, amino acids, and secondary metabolites. Many cyanobacterial species have the inherent ability to fix atmospheric nitrogen with the assistance of a highly specialized cell known as a heterocyst. The use of N_2 -fixing cyanobacteria as a potential N_2 -biofertilizer source in the field can serve as an alternative to conventional organic and chemical fertilizers [1-11].

3.10. Negative Effects of Blue-Green Algae in Soil

Blue-green algae may form algal blooms in some cases, releasing toxins into the soil and affecting vegetation directly or indirectly. The loss of a large cyanobacteria community in the soil

has an impact on the bacteria communities because it causes oxygen depletion.

4. Conclusions

Improve plant development and crop yield, and can greatly contribute to crop plant mineral nutrition these beneficial microbes have a direct impact on plant nutrition and growth via a variety of methods of action. These include atmospheric nitrogen fixation, organic matter decomposition, mineral solubility, and the release of chelating chemicals and physiologically active molecules such as phytohormones, vitamins and enzymes, as well as an increase in root system absorbing surface and soil-penetrating capabilities. Beneficial soil microorganisms also boost soil fertility and plant growth through indirect processes such as soil structure improvement, increased plant tolerance to a biotic stressors, suppression of phytopathogenic fungi and bacteria, and induction of plant resistance to diseases. In many cases, combining multiple bio fertilizers with diverse modes of action has been shown to have synergistic beneficial effects on plant nutrition and growth.

Conventional agriculture mainly relies on synthetic N fertilizers, although half of the N applied is wasted. This poses significant environmental risks. Considering the presence of nitrates in groundwater and implies a financial loss for the landowners, non-symbiotic soil microorganisms capable of fixing atmospheric N_2 are common. Spread over the soil, root surface, root interior, and plant aerial tissues the use of non-symbiotic N_2 -fixing bacteria can improve N management in more ways than one. "low-input" direction, and can be an important component of sustainable agriculture. Most soils have massive reserves of P that are unavailable to plants numerous soil and rhizosphere bacteria can be solved in soluble substances. Mineral phosphate complexes, mostly via acidification and the formation of acidic organic compounds they also influence the dispersion of organic phosphates. Phosphates from adsorbing surfaces are transferred to soil solution. Mycorrhizal fungi have high-affinity P absorption pathways and thus boost mycorrhizal P uptake plants. Furthermore, AMF determines root architecture alterations, such as increase in total root surface and volume, number of tips, and root branching degree and improve root soil exploring capability Under real-world conditions, the Use of P-solubilizing microorganisms in conjunction with mineral fertilizers such as The use of rock phosphate has frequently yielded positive results.

5. Acknowledgment

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6. Abbreviations

pH: Acidity

Eh: Redox potential

7. References

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Noise loading in beehives made out of different materials

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Abstract: Bees are highly sensitive to noise pollution and in some cases, noise can impact their behaviour. Towards the goal to create optimal living conditions for the bees, we aim to understand how the material of the beehive impacts the microclimate of the beehive. The present paper aims to examine and compare the noise levels inside beehives of the same construction but made out of different materials. Three 10-frame Dadan-Blatt beehives were used in the experiment – a ceramic beehive made out of high-cavity ceramic tiles of marl clay; a ceramic beehive made out of high-cavity ceramic tiles with increased kaolin content and a wooden beehive (pine). The noise was measured in an urbanized area and inside the beehives. The results show that the best performance in terms of noise insulation is the ceramic beehive with increased kaolin content.

Keywords: CERAMIC BEEHIVE, NOISE POLLUTION, BEES, BEEHIVE MICROCLIMATE

1. Introduction

Noise pollution or unwanted noise is the excessive sound that has bad effects on human health, wildlife and environmental quality. Noise pollution is mostly caused by the sound from highways, railways, airplanes, and any transportation traffic, from construction activities and industrial sites [1]. Noise pollution affects the health and wellbeing of many animals including bees.

It is known that bees are using for communication vibroacoustic signals produced by stridulation, gross body movements, wing movements, high-frequency muscle contractions without wing movements, and scraping mandibles or tapping body parts on resonant substrates [2]. For them, airborne sound and vibration signals have a great biological significance [3]. But when honey bees are subject to pure tones at frequencies from 100 to 1500 Hz audible at distance 250 m, the normal activities inside the beehive stop and the insects stop [4, 5]. Another study of the reaction of the honeybees inside the beehive confirms this statement showing that in the presence of sound with a frequency of 100 cy/sec (120 db) to 2000 cy/sec (128 db), it is observed a considerable effect expressed in total cessation on the movements of the workers and drones which even allowed the experimenters to open the beehive and take out a frame without using any smoke [6].

Some specialists argue that noise pollution is considerably affecting the wellbeing of bees creating a great amount of stress which is leading to increased mortality. Another effect on their behavior is the inclination to leave the beehive when exposed to increased stress factors like noise.

The data from the noise level measurements over the last 10 years show that the regulated permissible noise levels have been exceeded in 72% of the examined checkpoints in Bulgaria [7]. The relative share of points with exceeded levels has not changed since 2013, and the indicated results in the last measurements of 2019 and 2020 show a relative increase in noise levels above 61dB. A threshold value of 50 dB is taken as the norm. In most of the control points, the measured equivalent noise levels exceed the limit values with no tendency for improvement.

Increasing noise pollution is threatening the wellbeing of one of the most important pollinators in nature and it is necessary to start studying opportunities to improve their living conditions. Of course, it is hard to influence the environment outside the hive but it might be possible to influence the conditions inside it. One possible way to do so is through technical improvements or even through change in the construction material of the hive. Traditional beekeeping is connected with wooden hives and sometimes plastic or Styrofoam. Recently, a new type of beehive has been introduced to the beekeepers – a ceramic beehive made out of ceramic tiles with increased cavity. One of the advantages of such hives is the better insulation properties [8].

2. Aim

The aim of the present study is to examine and compare the noise levels inside beehives of the same construction but made out

of different materials in order to make conclusions about the comfort of the bees which each of them can provide in terms of noise insulation.

3. Methods

The examination has been conducted in the urbanized area of the industrial region of the city of Debeletz, Veliko Tarnovo District, Bulgaria. The evaluation has been performed during daytime (between 10:00 a.m. and 6:00 p.m.) for the period of 31 days, from 01.05.2022 to 31.05.2022. Noise levels have been evaluated by high-sensitivity super-cardioid condenser microphone brand BOYA type BY-MM1+ with the following characteristics:

Table 1. Technical characteristics of the used microphone

Converter	Electric capacitor
Polar diagram	Supercardioid
Frequency response	20 Hz-18kHz
Sensitivity	-36 dB +/- 3dB (0 dB = 1V/Pa, 1kHz)
Ratio Signal/ Noise	78 dB
Input plug	3,5mm TRRS line-out/ line output 3,5 mm TRS headphone output
Size	Φ26x100mm (Φ1x3.9")
Weight	60 gr. (2.1oz)

The beehives which were used for the experiment have the same construction, type 10-frames Dadan-Blatt, but the material of the walls is different, respectively from a ceramic beehive made out of high-cavity ceramic tiles of marl clay; a ceramic beehive made out of high-cavity ceramic tiles with increased kaolin content and a wooden beehive (pine). The beehives were not inhabited.



Fig.1. From left to right: A ceramic beehive made out of high-cavity ceramic tiles of marl clay; a wooden beehive (pine); a ceramic beehive made out of high-cavity ceramic tiles with increased kaolin content

Table 2. Coding

Beehive	Description
Beehive 1	A ceramic beehive made out of high-cavity ceramic tiles of marl clay
Beehive 2	a wooden beehive (pine)
Beehive 3	a ceramic beehive made out of high-cavity ceramic tiles with increased kaolin content

All beehives have a removable drawer-type bottom, which is tightly closed.

The microphone was installed in the beehives and there were measured average values for noise inside the hive. Levels of the environment were also measured.



Fig. 2. Installation of the microphone inside the beehive

The output is visualised in figure 3.

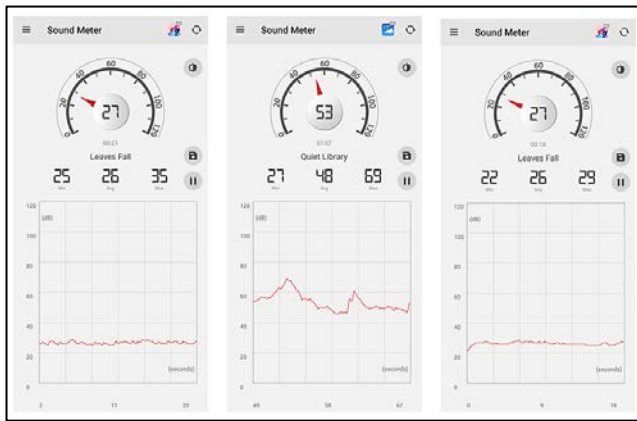


Fig. 3. Display of the results from the noise measurement, respectively for a ceramic beehive made out of high-cavity ceramic tiles of marl clay; a wooden beehive (pine); a ceramic beehive made out of high-cavity ceramic tiles with increased kaolin content

The obtained results for the 31-days period were statistically analysed using software IBM SPSS Statistics Software 2019.

4. RESULTS

According to Annex No. 2 of Ordinance No. 6 of June 26, 2006 [9], the maximum value of noise allowed in the urbanized area is 55 db(A) during daytime while in industrial regions, it is 70 db(A). During the time of the experiment, the noise in the area was evaluated to be between min = 32 to max = 61 db(A) with average value of 46 db(A) which is within the permitted levels for the area. Although the area is industrial, in the perimeter of 1 kilometer, there are 3 bee farms and the region is typical for beekeeping which makes the results from the present study relevant and applicable for the apiculture sector.

The following graph presents the evaluated levels of noise for the period. What we observe is that for the whole period of thirty-one days, the ceramic beehive with increased kaolin content (Beehive 3) is showing the best performance in terms of noise insulation.

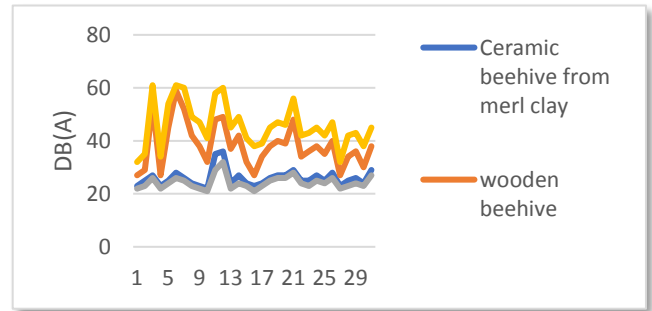


Fig. 4. Evaluated level of noise

The graph shows that the values of the ceramic beehive from merl clay (Beehive 1) and the ceramic beehive with increased kaolin content (Beehive 3) are close. In order to understand if the identified difference is significant or not we perform non-parametric statistical test - Related-Samples Friedman's Two-Way Analysis of Variance by Ranks. The results for the pairwise comparisons are presented on table 3.

Table 3. Pairwise comparison

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig. ^a
Beehive 3 – Beehive 1	1,000	,254	3,937	,000	,000
Beehive 3 – Beehive 2	2,000	,254	7,874	,000	,000
Beehive 1 – Beehive 2	-1,000	,254	-3,937	,000	,000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed.
The significance level is ,05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

What we see is that the difference of the levels of noise between the three beehives is statistically significant ($\alpha = 0.00 < 0.05$).

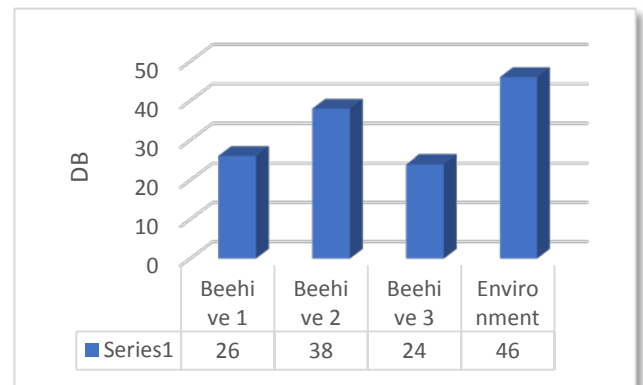


Fig.5. Levels of noise, average values for the period

The results displayed of figure 5 are average values for the indicated days in dB, and the graph clearly shows the relative ability to reflect and absorb noise of the different materials. The coefficient ratio $\alpha_n = R_{w_n}/R_{w_0}$, where R_{w_n} is the index of sound insulation from airborne noise inside hive in the range of 100-3150 Hz, where $n = 1, 2, 3$ is the number of the studied models, and R_{w_0} is the evaluated average noise in an urbanized environment.

$$\alpha_1 = 26/46 = 0.5652$$

$$\alpha_2 = 38/46 = 0.82$$

$$\alpha_3 = 24/46 = 0.5217$$

What we see is that in terms of noise insulation, the ceramic beehive with increased kaolin content has the best performance followed by the ceramic beehive made out of merl clay - $\alpha_3 < \alpha_1 < \alpha_2$.

5. *Conclusio*

With the high pace of industrial development, increased connectivity and transportation opportunities, and constantly growing number of people, we manage to create a lot of noise. Although in most parts of the world the noise level is regulated by law, we still manage to disturb the life and the regular habitat of many living creatures. The present study, discusses the importance of the level of noise for one of the most valuable insects - the honey bees. High levels of noise cause total cessation of the moves and there is no data about the influence of a constant exposure of lower noise. It is already a problem for the humanity the ability to provide them optimal living conditions and prevent loss and mortality and while it is hard to influence the environment, improving the living conditions inside the beehive is a much easier task. New approaches with construction and materials seem to give a solution. We can conclude that in terms of noise insulation, the ceramic beehives perform considerably better than the classical wooden one. This gives us the reason to think that such beehives will allow much less disturbance and respectively less stress of the bees in the hive.

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Comparison of Energy Savings Measures in Plant Fruit Storage Facility

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Abstract: This research will analyse the utilization of photovoltaic plant in a fruit storage facility to produce electricity for running the refrigerators to keep cool the fruit preservation in the Storage Facility. The building has two sets of refrigerators with a power of 18.2 kW each. Firstly, the work analysis deals with the convenience of installing a Photovoltaic Plant to produce electricity for supplying the refrigerators. Secondly, implementing energy efficiency measures such as adding a new layer of insulation to the walls has been analysed. Result analysis shows that the return of investment by the installation of Photovoltaic plant is less convenient compared to that of a thermal insulation layer on the interior sites. In conclusion, it has been decided to implement only thermal insulation as energy efficiency measures to this facility where the saving is about 15% of electricity consumption per year. Given that the saving in one year is 3069kWh and the cost of electricity is 0.09 EUR/kWh, the savings in monetary value is 276 EUR /year.

Keywords: PHOTOVOLTAIC PLANT, ENERGY SAVINGS MEASURES, REFRIGERATOR, THERMAL INSULATION

1. Introduction

In Albania, final energy consumption in building sector is equal to 30% percent of national consumption and the sector was responsible for the use of 60% of electricity, as part of final energy consumption. The service quality of electricity equipment is much lower than the European Union average [1].

Albania is a part of the Energy Community Treaty, so it is obliged to adopt EU legislation on energy efficiency. In April 2015, the country transposed Directive 2006/32 / EC on Energy Efficiency in End Users and Energy Services and Directive (ESD) 2010/30 / EU on Energy Product Labels (Former Directive 92/75 / EEC). In line with ESD, in 2018, the country should achieve energy saving targets of up to 9% of the total amount of energy sold, compared to 2010. According to the ESD, Albania should save 1.5% of the amount of energy each year sold compared to the period of the last three years, using the mandatory scheme for enterprises, or other alternative routes. Achieving these goals requires more ambitious policy and investment efforts than ever before for energy efficiency [2-4].

The main objective of this research work is the comparison of energy savings measures in plant fruit storage facility in the city of Korca (Albania). The project deals with the analysis of different energy efficient measurements and ends with the selection of most suitable one such as the implementation of thermal insulation.

2. General Description of Fruit Storage Building and Electricity Consumption Analysis

2.1 Architecture and Cooling Plant

The Fruit Storage building is located in the city of Korca (see Fig. 2.1). The building has the total area of $A = 150 \text{ m}^2$. Building is composed only with one floor with the height of about 6 meter. The facility is mainly used for conserving apples.



Figure 2.1 Fruit Storage Building in Korca

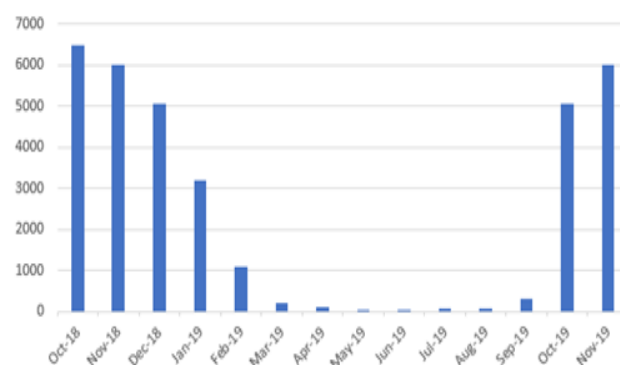
From the analysis made on the building, its architecture is composed with sheet metal cladding and a layer of thermal insulation in the middle. The building uses only electricity for running the cooling system and other electrical equipment such as lighting. Figure 2.2 presents the cooling system, and this plant is composed by two refrigerators with a power of 18.2kW each.



Figure 2.2 Cooling Plant

2.1 Electricity Consumption

The graphs in Figure 2.3 presents historical data on electricity consumption for each month for the years 2018 and 2019.



Months	Consumptions (kWh)
Oct-18	6497
Nov-18	6013
Dec-18	5057
Jan-19	3185
Feb-19	1090
Mar-19	190
Apr-19	113
May-19	10
Jun-19	48
Jul-19	55
Aug-19	62
Sep-19	289
Oct-19	5057
Nov-19	6013

Figure 2.3 Electricity Consumption [kWh /month]

3. Implementation of Energy Efficiency Measures

3.1 Implementation of Photovoltaic Panels for Electricity Generation

The area that could be installed the photovoltaic panel is 300m². From the technical sheet is given an average electricity production of 3kW per 30m² panel surface. As a result for an area of 300m² it can be generated 30kW of electricity.

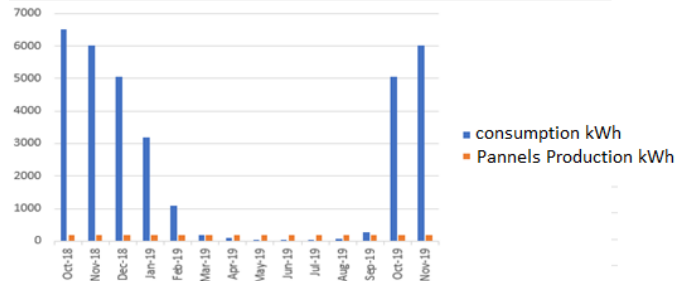


Figure 3.1 Electricity produced versus that consumed on monthly based

Figure 3.1 presents the electricity produced by the photovoltaic plant versus that consumed monthly for one year. From Fig 3.1 it can be shown that the photovoltaic panels can satisfy the electricity required by the facility from March to September. Throughout the remaining months, electricity produced by photovoltaic plants is about only 5% of the required energy consumed.

3.2 Calculation of Thermal Transmission Coefficient and Total Refrigeration Load

3.2.1 Existing Building

To analyze the thermal conductivities of the walls a software has been utilized called Design Builder [5]. Figure 3.2 presents external wall structure of the existing building. The wall is composed by three layers such as: sheet metal with 100mm layer, thermal insulation with 40mm thickness and 13mm aluminum layer. It has been calculated that, the value of the equivalent is transmission coefficient $K = 0.760$ [W/m² · K], while the total refrigeration load is $E_t = 52.39$ kW. It has to be noted by the result analysis shows that the effect of the roof and floor on heat transfer is negligible compared to that of the roof and the floor.



Figure 3.2 Exterior wall structure layers [5]

3.2.2 Improved Building

To further reduce the heat losses from the walls another insulation layer has been added such as improve the properties of the building in thermal with a thickness of 40mm. Figure 3.3 shows the improved wall composed by four layers. Results analysis from the software gives an equivalent heat transfer coefficient of 0.232 [kW/m² · K], which is smaller to that compared to the existing building. Finally, total cooling load is $E_{tm} = 48$ kW.

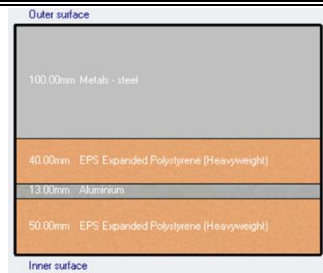


Figure 3.3 Exterior wall structure - Improved building [5]

3.2.3 Summary Results

Figure 3.4 presents a comparison between implementation of electricity generated by photovoltaic plant versus that by adding an insulation layer. Result analysis shows that implementation of Photovoltaic plant is less convenient compared to that by adding an insulation layer. Electricity savings is about 15% from 141.36 [kWh/m² year] to 122.58 [kWh/m² year]. Finally, the total electricity consumed: $E = 18100$ kWh/year. The saving in one year is 3069kWh/year. Given that the cost of electricity is 0.09 EUR/kWh, the savings in monetary value is: 3069kWh/year * 0.09EUR/kWh = 276EUR/year.

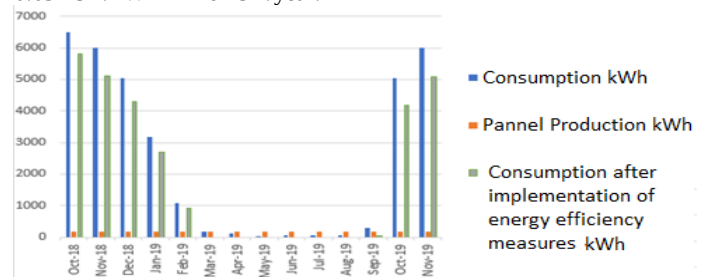


Figure 3.4 Summary results

4. Conclusions

In this work research the facility is analyzed to identify what is the most suitable energy efficiency measures to be applied. The aim of this work research is the comparison of energy savings measures in plant fruit storage facility in the city of Korca (Albania).

The existing building has an electricity consumption of 141.36 [kWh / m² year]. Energy efficiency measures includes addition of a thermal insulation layer and photovoltaic plants. Results analysis is conducted by utilizing an energy software [5]. Results analysis shows that adding thermal insulation layer is much more suitable compared to that of photovoltaic plant. In conclusion, after implementing thermal insulation layer the saving of about 15% of electricity consumption per year. On yearly basis the saving 3069kWh and taking into account the cost of electricity 0.09 EUR/kWh, the savings in monetary value is 276 EUR / year.

Finally, the methodology used in this research work can be used to analyze energy saving opportunities to other types of buildings.

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