Print ISSN 0554-5587
On line eISSN 2406-1123
UDK 631 (059)

ПОЉОПРИВРЕДНА ТЕХНИКА

AGRICULTURAL ENGINEERING

НАУЧНИ ЧАСОПИС
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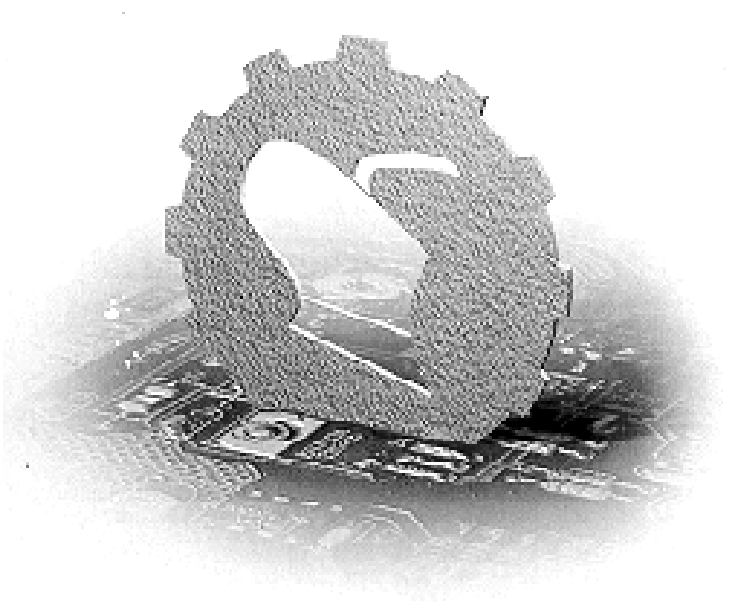

УНИВЕРЗИТЕТ У БЕОГРАДУ, ПОЉОПРИВРЕДНИ ФАКУЛТЕТ,
ИНСТИТУТ ЗА ПОЉОПРИВРЕДНУ ТЕХНИКУ
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Година XLV, Број 2, 2020.
Year XLV, No. 2, 2020.

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Пољопривредни факултет , 11080 Земун-Београд
Часопис излази четири пута годишње

Тираж *(Circulation)*
250 примерака
Дистрибуција примерака часописа Пољопривредна техника за заинтересоване је бесплатна .

Радови објављени у часопису индексирани су у базама *(Abstracting and Indexing)*:
AGRIS (International Information System for the Agricultural Science and Technology)
SCIndeks (Serbian Citation Index)
NAAS (National Academy of Agricultural Sciences - India)
ScienceMediaCentre
ArgosBiotech
CiteFactor (International Academic Scientific Journals)
J4F (Journals for Free).

Издавање часописа помогло *(Publication supported by)*
Министарство просвете, науке и технолошког развоја Републике Србије

На основу мишљења Министарства за науку и технологију Републике Србије према решењу бр. 413-00-606/96-01 од 24. 12. 1996. године, часопис Пољопривредна техника је ослобођен плаћања пореза на промет робе на мало.

S A D R Ž A J

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Univerzitet u Beogradu
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POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 1 – 7

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 1 – 7

UDK: 338.43.1.

Original scientific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002001V

IMPORTANCE OF IMPLEMENTATION OF DECISION MAKING FLOW BY INTERNAL AUDIT TO TOP MANAGEMENT OF AGRICULTURAL ENTERPRISE IN REPUBLIC OF SERBIA

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Abstract: Internal audit should contribute to and ensure the safety of top management in all enterprises, and in particular in agricultural enterprises that rely on primary agriculture and processing of agricultural products. Internal audit, introduced into the regular control flows, enables the proper functioning of the existing management processes, especially the risk management of the top management's business and key decisions.

In addition, internal audit contributes to an increase in the control function and management of the company, that is, management processes that are close to the planned activities of top management, thus enabling the achievement of the basic goals of the company that is made by top management.

Key words: *internal audits, process management, agriculture, risks.*

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INTRODUCTION

The introduction of an internal audit enables the ever-increasing exercise of functions in any company [1] [2], [3], [4], [5], and in recent years, in the transition conditions, it has been of dominant importance in agricultural enterprises. Internal audit reports in the form of recommendations are submitted to top management with the aim of optimizing [6], [7], [8] the future management of the company.

Top management, if it wants to improve business results [9], [10], starting with the increase of production, increase of turnover, increase of profit, must pay attention to the recommendations of internal audit, because in the presentation of the results of internal audit, internal audit, opinion and the findings of the internal auditor and must provide guidance in their work that is consistent with the legislation [11].

Corporate governance in a large number of enterprises, and therefore in sub-agricultural enterprises, is based on the use of corporate finance management principles. A large number of heterogeneous legal entities respond differently to business decisions made. Management should monitor performance to ensure that activities are carried out optimally economically, efficiently and effectively.

Therefore, internal audit should result, first and foremost, in the field of quality control, both in production and in the sphere of sale of agricultural products and products.

Activities should be embedded in the management system, and any company with development aspirations should make adequate decisions that are timely, thought-out and development-oriented.

Management data are reviewed regularly to verify that they are appropriate for the agricultural undertaking. In addition, the performance of the business results must be valid in relation to the engagement inputs as regards the efficiency, cost-effectiveness and quality of service provided by the agricultural enterprise.

MATERIAL AND METHODS

The authors gave a possible sequence of events related to business decision-making in the agricultural enterprise, which implements the recommendations of the company internal audit. The authors provide a general model of the decision-making flow in Figure 1.

Modern business requires a new approach, which basically defines a large number of jobs that requires a new approach, which is reflected in the increasing degree of standardization of jobs, but also with the increasing operational risk and the speed of action towards management.

The general model of application is given by the authors as a general approach to the theoretical model of company behavior. The general model is presented in Table 1 by the authors.

The legal framework for the existence of public enterprises based on agriculture is made up of public enterprises, not so numerous, but it is necessary to emphasize that in the Republic of Serbia such enterprises are subject to special laws, such as:

the Law on Budget System ("Official Gazette of RS", no. 54/2009, 73/2010, 101/2010, 101/2011, 93/2012, 62/2013, 63/2013-corr., 108/2013, 142/2014, 68/2015, 103/. 2015) [12].

In addition, I must respect: the existence of the Rulebook on Common Organization Criteria and Standards and Methodological Guidelines for the Implementation and Reporting of Internal Audit in the Public Sector ("RS Official Gazette", No. 99/11 and 106/13) [13].

RESULTS AND DISCUSSION

Presentation of important partial factors in the decision-making of top management that is aging and managing the operation of agricultural enterprises in the Republic of Serbia can be viewed in several ways. In this paper, the authors present a survey of 10 surveyed companies that are predominantly related to agricultural enterprises. The analysis covered the efficiency of the use of capital in the period 2014-2018, which concerned the analysis of profit margins, turnover of total assets, turnover of business assets, turnover of fixed assets, and turnover of current assets.

The views in Table 3 are given as an average of the sizes of 10 randomly analyzed companies, and the data obtained were obtained by primary processing of the final accounts data for the survey years shown.

The Internal Auditor performs his / her activities on the basis of procedures based on the previously adopted Charter on Internal Audit and the powers conferred by top management. In addition, an internal audit needs to define more precisely the area of business within an enterprise, such as accounting and company finance for a specified period.

The following is the designation of the person who will perform the internal audit, relative to the company's internal auditor. It then defines to whom the reports and recommendations are intended, for example: Internal Audit and Internal Audit Department, Chief Financial Officer, General Directorate, Board of Directors, etc.

In order to carry out audit procedures, the internal auditor proposes to agree on the dates for meetings of relevant persons.

The purpose of the working meetings is to inform the top management of the objectives, scope and procedures of the audit, as well as to provide answers to the issues that need to be highlighted in particular regarding the system audit.

The exact time and date of the meeting will subsequently be agreed upon in accordance with the obligations of the participants and will be notified to the internal auditor with the main activities.

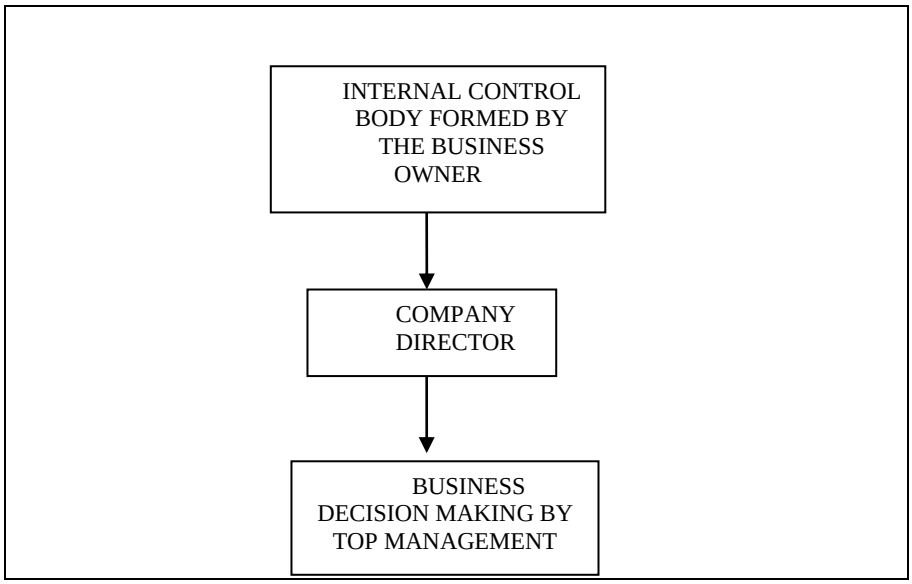

Fig. 1 Model of harmonization of internal control mechanisms in the Republic of Serbia

Table 1. Presentation of standardization form with description of possible control and possible level of risk for business of agricultural enterprise

Forms of standardization	*Requirements regarding the performance of control and audit*	*Possible risk level per company*	*Undertaking Management activities*
Attribute standard	*Applying standard requires a professional attitude, competence and professional care, competence, knowledge and other competencies to perform internal audits.*	*Medium*	*Directly after the knowledge*
Implementation standards	*The auditor must obtain help, if there is no knowledge, skills, or other competencies needed to perform all tasks related to the audit or his involvement.*	*High*	*Immediately*
Performance standards	*The auditor must effectively manage internal audit activities. Must plan and prioritize internal audit, based on the assessed risk.*	*High*	*Immediately*
Implementation Standards-advice	*The auditor should consider accepting proposed involvement in the assessment and should propose improving the organization of the subject in which audits. Data Solutions suggestions.*	*High*	*Immediately*

Table 2. Showing framework regulating the work of internal auditors in the R. of Serbia

Serial number	*The existence of a legal framework*	*Where were published*	*Possible risk level per comp.*
1.	*Law on Budget System*	*"Off. Gazette of RS", Nos. 54/2009, 73/2010, 101/2010, 101/2011, 93/2012, 62/2013, 3/2013 corr., 108/2013, 142/2014, 68/2015-other. 103/2015 and law"*	*High*
2.	*Regulations on common criteria for organization and standards and methodological guidelines for the conduct and reporting of internal audit in the public sector*	*"Off. Gazette of RS "no. 99/11 and 106/13*	*High*
3.	*Internal Audit Charter companies*	*NO. (...) From the date when it was adopted (...) years*	*Medium*
4.	*Authority given to the internal auditor by Directors*	*NO. (...) From the date when it was adopted (...) years*	*Low*

Table 3. Showing indicators of capital use for the period 2014-2018 in agricultural enterprises based on a random survey of 10 enterprises

Indicators	*Years*				
	2014	*2015*	*2016*	*2017*	*2018*
Profit margin	*1%*	*-*	*-*	*-*	*-*
Crafts of total property	*1,96*	*2,06*	*2,40*	*2,64*	*2,64*
Craft business property	*1,96*	*2,06*	*2,40*	*2,64*	*2,64*
Fixed property crafts	*4,73*	*5,40*	*6,67*	*6,44*	*6,65*
Property	*3,24*	*3,57*	*3,72*	*3,77*	*4,25*

CONCLUSIONS

Contemporary management requires new ways of implementing the organization of work of top management. This requires the use of new working methods.

In this paper, the authors emphasize the importance of using control mechanisms, more specifically the use of internal audit in the functioning of an agricultural enterprise.

The results indicate the positive business trends of a company whose management has opted for the implementation of internal audit and the use of recommendations provided by internal auditors to achieve improvement in corporate governance. Thus, internal audit becomes a significant factor that can contribute to improving management in an agricultural enterprise.

The authors point out that with the introduction of internal audit and the obligation to provide rapid and qualitative reporting in the form of recommendations made by internal auditors to top management, the overall management of an agricultural enterprise can be improved in the short term.

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ZNAČAJ IMEPLEMENTACIJE TOKA ODLUČIVANJA OD STRANE INTERNE REVIZIJE PREMA TOP MENADŽMENTU POLJOPRIVREDNOG PREDUZEĆA U REPUBLICI SRBIJI

Jelena Vitomir[1], Bogdan Laban[2], Dragana Popović[3], Vera Popović[4], Dalibor Dončić[5], Ranko Mijić[6]

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Sažetak: Interna revizija treba da doprinese i obezbedi sigurnost u radu top menadžmenta u svim preduzećima, posebno u poljoprivrednim preduzećima koja se oslanjaju na primarnu poljoprivredu i preradu poljoprivrednih proizvoda. Interna revizija, uvedena u redovne tokove kontrole, omogućava pravilno funkcionisanje postojećih procesa upravljanja, posebno upravljanja rizikom poslovanja top menadžmenta u momentima donošenja ključnih poslovnih odluka.

Pored toga, interna revizija doprinosi povećanju kontrolne funkcije u upravljanju preduzećem, odnosno upravljačkim procesima koji su bliski planiranim aktivnostima top menadžmenta, omogućavajući postizanje zadovoljavanja osnovnih ciljeva kompanije koji su postavljeni pred top management.

Ključne reči*: interna revizija, upravljanje procesima, poljoprivreda, rizici.*

Prijavljen: *Submitted*:	03.12.2019.
Ispravljen: *Revised*:	01.05.2020.
Prihvaćen: *Accepted*:	05.05.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
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Strane: 8 – 20

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Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 8 – 20

UDK: 631.6:631.536

Original scientific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002008N

COMPARATIVE STUDIES ON PROXIMATE COMPOSITIONS AND FUNCTIONAL PROPERTIES OF TRIFOLIATE YAM FLOUR VARIETIES

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Abstract: The effect of drying methods on proximate composition and functional properties of Trifoliate Yam were investigated. The sample was dried using sun and oven drying methods. The dried sample were later milled and sieved with standard sieve for effective results. Association of Official Analytical Chemist (A.O.A.C) standard methods were used to determine the functional properties and proximate analysis of Trifoliate Yam flour sample. The results indicated that nutritional composition showed a high level of protein, carbohydrates (dietary fibre) for Oven dried sample while the high level of fat were noticed at Sun dried sample which are essential for man and livestock. The functional properties showed that these Trifoliate Yam displayed diverse functional characteristics. From the studies it is believe that the Trifoliate Yam flour have both great nutritional and functional values which could be used to meet the nutritional needs of the populace. Therefore, when functional properties and proximate composition of the sample are concerned the Oven drying method give a better functional and nutritional values. The ANOVA showed that Oven drying had significant effect on the functional properties and proximate composition across the specie tested.

Key words*: Functional properties, proximate composition, trifoliate yam, drying methods.*

[*]Correspondeng Author. E-mail address. patrick.ejike@esut.edu.ng.
The author is grateful to Dr. Paul. C. Eze for editing this research work.

INTRODUCTION

Yam (*Dioscorea* sp.) is one of the most important food crops in West Africa especially Nigeria and is well accepted as a staple food in most homes [18]. Yams are both annual and perennial tuber-bearing and climbing plants with more than 600 species in which only few are cultivated for food and medicine [13]. The most cultivated species in Nigeria are the white yam (*D. rotundata*), yellow yam (*D. cayenensis*), water yam (*D. alata*) and trifoliate yam (*D. dumetorum*) [7]. Trifoliate yam (*Dioscorea dumetorum*) is however underutilized yam among the species. The tubers are eaten during the time of famine or scarcity and are usually boiled with the peel and eaten as boiled yam.
Trifoliate yam hardens few days after harvest and this leads to reduction in moisture and starch content and increase in sugars and structural polysaccharides [5].

Triofoliate yam has been reported to be nutritionally superior to the commonly consumed yams with high protein and mineral content [14]. In an attempt to explore these benefits and to add more value to *D. dumetorum* as an important source of food and energy, [15], [16] developed schemes for processing of its hardened tubers into flours and suggested that these flours can be used in bakery. Some literature has been reported by some authors [20]; [4]*;* [9]*;* [12]; [8]; [10] and [3] on the chemical composition of Trifoliate yam flour using different processing methods but no literature was cited on the effect of different drying methods on the functional properties and proximate composition of three varieties of trifoliate yam flour dominant in Nsukka, Enugu State, Nigeria. Therefore, there is need to increase utilization of yam through industrial processing to minimize post-harvest losses which in turn may lead to increased earnings from this crop. The starch content of the tuber presents prospects for the processing of yams into starches. Currently, yams are not listed among the most common sources of industrial starch which is principally provided by corn, potato, wheat, tapioca and rice [12]. Starch is an important raw material for a number of industries including textiles, paper, adhesives, pharmaceuticals and food. As a country becomes more industrialized, demand for both native and modified starches increases but these demand are rather met through imports instead of locally made starch. D. *dumentorum spp* is not a widely studied variety. The post-harvest hardening phenomenon problem has an adverse effect on the productivity of the yam. Starch production and evaluation is therefore carried out in order to improve the utilization of trifoliate yam locally and industrially. This will reduce dependence on starch importation and thus increase the industrial utilization from locally available raw material. The result from this research will benefit the breeders, processors and other researchers. The objective of this work therefore is to evaluate the effect of drying methods on functional properties and proximate composition from three varieties of trifoliate yam flour.

MATERIALS AND METHODS

The three cultivars of trifoliate yam (yellow, white and deep-yellow) were obtained from a local farm in Obolla-Afor, in Udenu Local Government Area of Enugu State, Nigeria.

Figure 1. Trifoliate Yam sample used for the experiment

PREPARATION OF TRIFOLIATE YAM FLOUR

The tubers were washed with distilled water, peeled and sliced at uniform thickness of 10mm using stainless kitchen knife .The slices were drained using plastic sieve and then divided into two equal batches of the same quantity. First batch of the slices of the three varieties of Trifoliate Yam were dried in hot air oven (Multi-Purpose Oven (Model OKH-HX-1A) China) at 70°C with the weight being measured at interval of 20 minutes until a constant weight was obtained. Second batch was sun-dried for 4 days at 29-30°C and 60 - 70% relative humidity. The six dried Trifoliate Yam samples were milled into flour using hammer mill, packaged in polythene bags, sealed and then stored in air tight containers with appropriate labeling and then carried to the laboratory were, functional properties and proximate composition was investigated.

DETERMINATION OF FUNCTIONAL PROPERTIES OF THE TRIFOLIATE YAM FLOUR

Functional characteristics of food products are the food parameters that measure food application and its end use. It usually tells how the biomaterials under test will respond to other food components either directly or indirectly affecting food quality, processing applications and ultimate acceptance [11].

This study narrowed its interest on some functional properties like swelling power, solubility, bulk density, foaming capacity, oil and water absorption capacity, emulsification and gelatinization.

Gelation (%).

In a test tube, a sample suspension of 2.20% (w/v) in 5ml of distilled water was prepared in test tubes. The sample was heated in boiling water bath at 60mins and rapidly cooled in a bath of cold water. The test tube was allowed to cool for the next two hours at 40^0C. The gelation capacity which is the least gelation concentration measured when the concentration of the sample from the inverted test tube will not fall. This method was reported by [19].

Emulsification capacity (%)

EC was measured by addition of (2g) of the flour sample with 100ml of distilled water which was blended for 30sec at 100rpm speed. After complete diffusion, peanut oil was added from a burette in streams of about 5ml. Blending persist until the blend separate into two distinct layers. Then emulsion capacity was determined as grams of oil emulsified by 1g flour. Triplicate measurements will be made and average results taken. This method was adopted by [11].

Foaming capacity (%)

Foaming capacity was measured by adding 2g of flour sample in a 50ml of distilled water in a 100 ml measuring cylinder. The mixed sample was properly shake to foam and the maximum volume after 30s was recorded. The foaming capacity of the sample was the percentage increase in volume after 30s.This was reported by [11].

Oil absorption capacity (OAC)

The mixture of 1g of flour with 10 ml refined corn oil in a centrifuge tube allowed to stand at room temperature 30 ± 2°Cfor 60mins It was centrifuged at 1600g for 20min. The volume of free oil was noted and poured. Fat absorption capacity was measured as ml of oil bound by 100g dried flour [11].

Water absorption capacity (%)

In 15 ml centrifuge tube 1g of the flour was weighed and poured in 10ml measuring cylinder of water. It was shaken on a platform tube rocker for 1 minute at room temperature. The sample was allowed to stand for 30 min and centrifuged at 1200g for30 min. The volume of free water was read directly from the centrifuge tube.

Swelling power (SP)

According to [22]., 3g of the flour sample was partitioned and each part of the dried flour was transferred into clean, dry, calibrated 50ml cylinders. Flour samples were slightly leveled and their volumes were recorded. 30ml distilled water was added to each sample then the cylinder was allowed to be swirled and stand for 60 minutes while the swelling power (change in volume) was recorded at 15 minutes interval.

The swelling power of each flour sample was calculated at interval of 15 minutes at each volume raised.

Solubility (%)

Cold water extraction method was used to determine solubility. The flour was divided into 10% w/v (db) was prepared with each of the flour samples by dissolving it in 1g (db) of flour in 5ml distilled water measuring cylinder and adding it up to 10ml. the sample allowed for 60 minutes and stirred at each 10 minutes. The sample was allowed to settle for 15 minutes after 2ml of the supernatant were measured in a dry Petri dish evaporated to dryness and re-weighed. The change in mass is the total soluble solids and this was calculated using the equation reported by [21].

$$Solubility = TSS(\%)\frac{(VsMe - Md)}{2MS1}x\ 100 \quad \ldots\ldots(1)$$

Vs = Total supernatant/ filtrate;
Md= Mass of empty, dry Petri dish;
Me = Mass of Petri dish plus residual solid after evaporative drying.

DETERMINATION OF PROXIMATE COMPOSITION OF THE TRIFOLIATE YAM

Proximate analysis of bio-materials describe the basic nutrient composition of the bio-material in terms of crude protein, moisture content, fat, ash, fiber and carbohydrate. The flour samples were analyzed for moisture content, dries matter, crude protein, crude fiber, fat, ash and carbohydrate using Approved Methods of The American Association of Cereal Chemist [2]. All the chemicals were of analytical concentration.

The moisture content of the samples where determined using the procedure described by [2].The moisture content was determined by weighing 5g of the flour sample into aluminum Can. The sample was then dried to a constant weight at 105.

$$\boldsymbol{MC = \frac{W_w - W_D}{W_D} X\ 100\%} \quad \ldots..(2)$$

Where:
MC = moisture content (%);
W_w = weight of wet sample (g);
W_D = weight of dry sample (g)

The crude fiber was determined using Method [1]. This involves transferring 2g of the sample into 1litre of conical flask. Then heating 100ml of water until it boils and pouring it into the conical flask that contains the samples, the mixture were then boiled together for about 30 minutes.

After boiling for 30 minutes, the mixture was filtered using a Muslin cloth held in a funnel. The residue was thoroughly rinsed until it was no longer alkali. The residue was then poured into an already dried crucible and ached at 600^{o}C ± 200^{o}C. The crude fiber was evaluated using the equation below.

$$\boldsymbol{Crude\ fiber}\ \frac{\boldsymbol{weight\ of\ crucible}}{\boldsymbol{weight\ of\ the\ sample}}\ \boldsymbol{X}\ \mathbf{100}\% \tag{3}$$

Determination of the Ash Content

The ash content represents the mineral or organic residue of a bio-material. It gives an idea of the amount of total mineral content of the food material**.** The ash content was determined using [1], [6].

$$\boldsymbol{Ash\ content}(\%) = \frac{\boldsymbol{weight\ of\ Ash}}{\boldsymbol{weight\ of\ sample}}\ \boldsymbol{X}\mathbf{100}\% \tag{4}$$

Determination of Crude Fat Content

The Crude Fat content was evaluated using procedure proposed by [6] by using Soxhiet extractor with Hexane. 1g of the samples was measured into a thimble extractor placed into extraction chamber with some Hexane added to extract the fat. The fat was evaluated using equation below

$$\boldsymbol{Crude\ fat}(\%) = \frac{\boldsymbol{weight\ of\ fat}}{\boldsymbol{weigth\ of\ sample}}\ \boldsymbol{X}\ \mathbf{100}\% \tag{5}$$

Determination of Crude Protein

Protein is amino acids joined together by peptide linkage. They contain essential elements such as Carbon, Hydrogen, Oxygen and Nitrogen etc. The Crude Protein was evaluated using Foss Desiccators, Protein Digester and KJECTEC2200 Distillation apparatus using [1], [6] procedure.

$$\boldsymbol{Crude\ protein} = (\boldsymbol{Titre\ value\ of\ the\ sample} - \boldsymbol{Blank})\boldsymbol{X}\frac{\mathbf{0.01}\boldsymbol{X}\ \mathbf{14.007}\ \boldsymbol{X}\ \mathbf{6.25}\ \boldsymbol{X}\ \mathbf{100}}{\mathbf{1000}\ \boldsymbol{X}\ \boldsymbol{weight\ of\ thesample}} \tag{6}$$

RESULTS AND DISCUSSION

Effect of Drying Methods on Functional Properties of Trifoliate Yam Flour

Figure 1-2 and Table 1., shows the functional properties of the trifoliate yam species based on the drying methods selected. The results obtained from Oven drying method are 0.57 (g/ml), 3.15(g/g), 2.82(g/g), 2.06(g/g), 12.00(%), 19.60(%), 24.86(%), 12.76 (%) for WTY, 0.63(g/ml), 4.68(g/g), 2.80(g/g), 3.90(g/g), 6.00(%), 24.72(%), 23.45(%), 10.70(%) for YTY, 0.42(g/ml), 3.53(g/g), 1.75(g/g), 3.00(g/g), 10.00(g/g), 18.72(g/g), 14.83(%), 10.60(%) for DYTY and the properties tested where;

bulk density, swelling index, oil and water absorption capacity, gelation capacity, foaming capacity, emulsification capacity, solubility respectively.

While the result obtained from Sun drying were 0.57(g/ml), 2.96(g/g), 2.14(g/g), 1.70(g/g), 8.00(%), 23.60(%), 19.76(%), 13.50(%) for WTY, 0.64(g/ml), 3.84(g/g), 2.75(g/g), 3.80(g/g), 6.00(%), 21.76(%), 22.65(%), 9.24(%) for YTY, 0.43(g/ml), 4.04(g/g), 2.85(g/g), 1.68(g/g), 8.00(%), 21.72(%), 24.83(%), 10.28(%) for DYTY and the properties tested were; bulk density, swelling index, oil and water absorption capacity, gelation capacity, foaming capacity, emulsification capacity, solubility respectively. It was observed that high values were obtained for emulsification and gelation capacity and also solubility for both drying methods with the highest being for emulsification. Other properties varied and bulk density was observed to have the lowest value for both drying methods. Given the similarities in the values of functional properties it can be inferred that specie have very little effect on the functional properties of the samples tested. The significant values of gelation capacity were an indication of protein in the samples despite it being a tuber. This is in line with what was opined by [17] that increase in concentration of protein in a sample increases its gelation property.

Table 1. Functional Properties of Three Different Species of Trifoliate Yam

Drying method	*Sample name*	*Bulk dens. (g/ml)*	*Swelling Index*	*Oil absorp. cap. (g/g)*	*Water absorp. capacity (g/g)*	*Gelation capacity (%wt/vol)*	*Foaming capacity (%)*	*Emulsif. capacity (%)*	*Solubility*
VEN DRIED	*WTY*	*0.57*	*3.15*	*2.82*	*2.06*	*12.00*	*19.60*	*24.86*	*12.76*
	YTY	*0.63*	*4.68*	*2.80*	*3.90*	*6.00*	*24.72*	*23.45*	*10.70*
	DYTY	*0.42*	*3.53*	*1.75*	*3.00*	*10.00*	*18.72*	*14.83*	*10.60*
SUN DRIED	*WTY*	*0.57*	*2.96*	*2.14*	*1.70*	*8.00*	*23.60*	*19.76*	*13.50*
	YTY	*0.64*	*3.84*	*2.75*	*3.80*	*6.00*	*21.76*	*22.65*	*9.24*
	DYTY	*0.43*	*4.04*	*2.85*	*1.68*	*8.00*	*21.72*	*24.83*	*10.28*

WTY White Trifoliate Yam, YTY Yellow Trifoliate Yam, DYTY Deep-Yellow Trifoliate Yam.

The ANOVAs for functional properties of the tested samples. It can be observed that for both drying methods, the F-values for between species variations were found to be lower than the F-critical values (1.4 and 0.14 < 3.74). We therefore accept the null hypothesis. This means that neither the employed drying methods nor difference in species significantly affected the functional properties. However, within each trifoliate yam species there were statistically significant variations as seen in the F-values (32.32 and 106.20 > 2.76). The alternate hypothesis is accepted in both these cases.

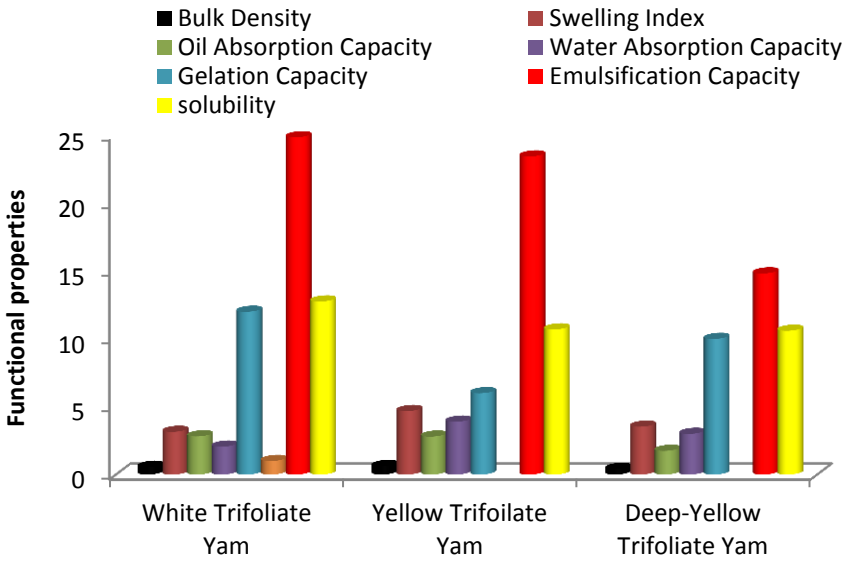

Figure 1. Effect of Oven drying on Functional properties of Trifoliate Yam Varieties

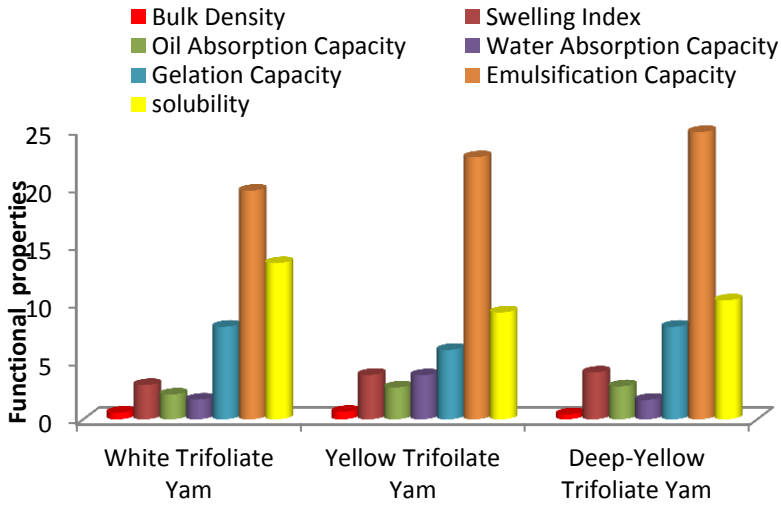

Figure 2. Effect of Sun drying on Functional properties of Trifoliate Yam Varieties

Effect of Drying Methods on proximate composition of Trifoliate Yam Flour

The proximate composition of the three species of the trifoliate yam samples are shown in figures 3-4 and Table 4**.**

The result obtained from Oven drying method were 6.80(%), 93.20(%), 1.69(%), 5.96(%), 10.76(%), 1.83(%), 291.60(kJ), 72.90(%) for WTY, 10.52(%), 89.48(%), 2.12(%),4.76(%), 9.60(%), 2.19(%), 270.29(kJ), 65.45(%) for YTY, 10.28(%), 89.72(%), 1.75(%), 4.85(%), 8.45(%), 21.13(%), 290.16(kJ), 72.54(%) for DYTY and the properties tested were dried matter, ash content, crude protein, fat, crude fiber, energy and carbohydrate respectively. While the result obtained from Sun drying method were 6.84 (%), 93.16(%), 1.80(%), 4.86(%), 19.45(%), 2.42(%), 258.70(kJ), 62.70(%) for WTY, 9.70(%), 90.30(%), 1.92(%), 3.90(%), 9.40(%), 2.18(%), 292.42(kJ), 65.43(%) for YTY, 11.45(%), 88.55(%), 1.76(%), 5.60(%), 10.60(%), 2.24(%), 273.20(kJ), 68.30(%) for DYTY and the properties tested were dried matter, ash content, crude protein, fat, crude fiber, energy and carbohydrate respectively. Dried matter and Carbohydrate were observed to be more in all species and for both drying methods. Similar values obtained for proximate parameters show that neither drying methods nor species had much effect on the proximate composition of the tested trifoliate yam samples.

Table.4. Proximate Analysis of Three Different Species of Trifoliate Yam

Drying method	*Sample name*	*Moisture content*	*Dried matter*	*Ash content*	*Crude protein*	*Fat*	*Crude fiber*	*Energy*	*CHO*
VEN DRIED	*WTY*	*6.80*	*93.20*	*1.69*	*5.96*	*10.76*	*1.83*	*291.60*	*72.90*
	YTY	*10.52*	*89.48*	*2.12*	*4.76*	*9.60*	*2.19*	*270.28*	*65.45*
	DYTY	*10.28*	*89.72*	*1.75*	*4.85*	*8.45*	*2.13*	*290.16*	*72.54*
SUN DRIED	*WTY*	*6.84*	*93.16*	*1.80*	*4.86*	*19.45*	*2.42*	*258.70*	*64.70*
	YTY	*9.70*	*90.30*	*1.92*	*3.90*	*9.40*	*2.18*	*292.42*	*65.43*
	DYTY	*11.45*	*88.55*	*1.76*	*5.60*	*10.60*	*2.24*	*273.20*	*68.30*

WTY White Trifoliate Yam, YTY Yellow Trifoliate Yam, DYTY Deep-Yellow Trifoliate Yam

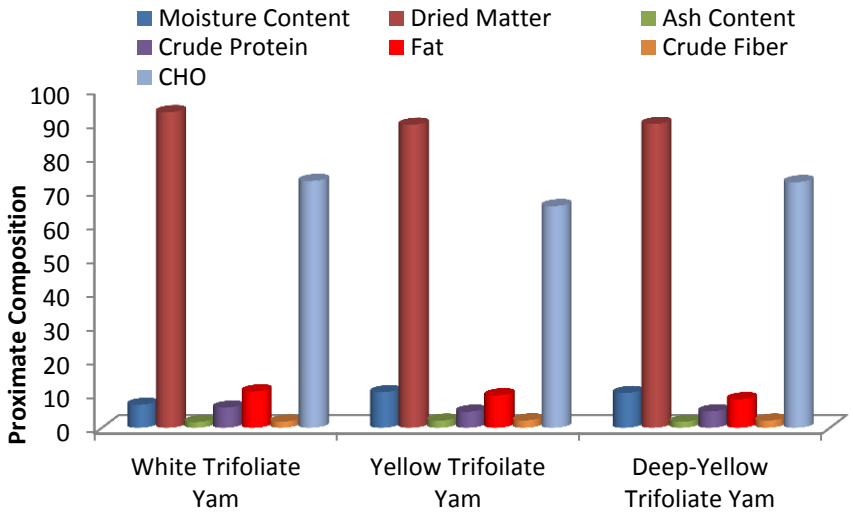

Figure 3. Effect of Oven drying on Proximate Composition of Trifoliate Yam Varieties

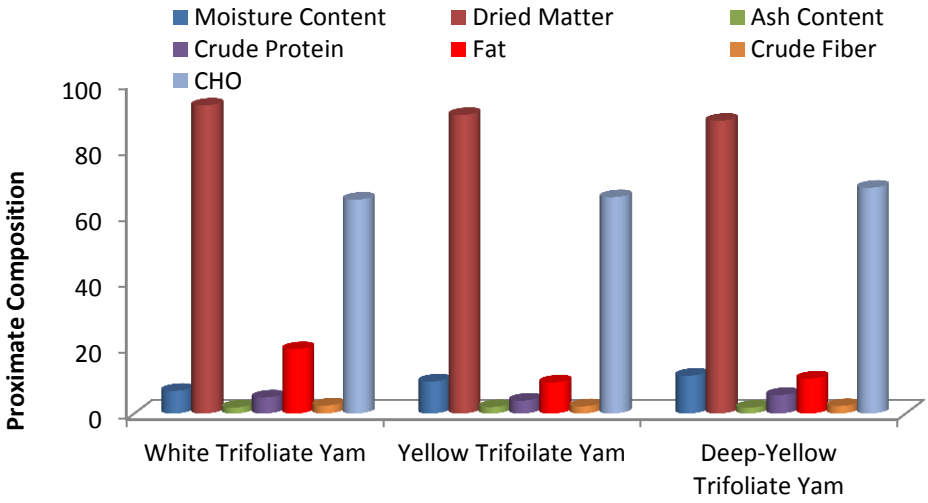

Figure 4. Effect of Sun drying on Proximate Composition of Trifoliate Yam Varieties

The ANOVA's for proximate composition (tables 5 and 6) followed similar pattern with those of functional properties. Both drying methods had F-values for variation between species lower than F-critical values (1.69 and 0.38< 3.73).

For variation within species, both methods also had higher F-values than F-critical (1447.64 and 587.93 > 2.76). We therefore accept the null hypothesis for variation between species and reject it for variation within.

CONCLUSION

From the results and analysis carried out in this study we can conclude on the following;

The results obtained from this work have given an insight of the nutritional and functional properties of three different of Trifoliate Yam species. The nutritional composition showed a high level of protein, carbohydrates (dietary fibre) for Oven dried sample while the high level of fat were noticed at Sun dried sample which are essential for man and livestock. The results of the studies on functional properties showed that these Trifoliate Yam displayed diverse functional characteristics.

From the studies it is believe that the Trifoliate Yam flour have both great nutritional and functional values which could be used to meet the nutritional needs of the populace. Therefore, it is advised to apply oven drying method when the proximate composition and functional characteristics of the flour sample are concerned, because it give a better functional and nutritional values. The ANOVA showed that Oven dry method had significant effect on the functional properties and proximate composition across the specie tested.

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KOMPARATIVNA STUDIJA SASTAVA I FUNKCIONALNIH OSOBINA BRAŠNA OD TROLISNIH VARIJETETA YAMA

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The author is grateful to Dr. Paul. C. Eze for editing this research work.

Sažetak: Istraženi su uticaji metoda sušenja na neposredni sastav i funkcionalna svojstva trolisnih varijeteta Yam kulture. Uzorak se suši korišćenjem metoda prirodnog sušenja i sušenja u sušari. Osušeni uzorak je kasnije samleven i prosejan standardnim sitom za efektne rezultate. Za određivanje funkcionalnih svojstava i neposredne analize uzorka brašna trolisne Yam kulture upotrebljene su zvanične standardne metode Asocijacije analitičke hemije (A.O.A.C). Rezultati su pokazali da prehrambeni sastav uzoraka pokazuje visok nivo proteina, ugljenih hidrata (dijetalnih vlakana) za uzorak sušen u peći (sušari), dok je visok nivo masti konstatovan u uzorku sušenom na suncu (prirodnim putem), koji je neophodan za čoveka i stoku.

Funkcionalna svojstva pokazaju da trolisni varijeteti kulture Yam pokazuju različite funkcionalne karakteristike. Studija pokazuje da brašno trolisnih varijeteta Yam ima velike hranjive i funkcionalne vrednosti koje bi se mogle koristiti za ispunjavanje nutritivnih potreba stanovništva. Zato, kada su u pitanju funkcionalna svojstva i neposredni sastav uzorka, metoda sušenja u sušarama daje bolje funkcionalne i hranjive vrednosti.

Rezultati ANOVA analize pokazuju da sušenje u sušarama ima značajan uticaj na funkcionalne osobine, neposredni sastav i kompoziciju za sve ispitivane varijetete kulture Yam.

Ključne reči*: Funkcionalna svojstva, neposredni sastav, trolisni Yam, metode sušenja.*

Prijavljen: *Submitted*:	26.12.2019.
Ispravljen: *Revised*:	10.01.2020.
Prihvaćen: *Accepted*:	14.02.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 21 – 27

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 21 – 27

UDK: 338.43.1.

Pregledni rad
Rewiev paper
doi: 10.5937/PoljTeh2002021J

IMPORTANCE OF PREPARING THE AUDIT REPORT FOR THE TOP MANAGEMENT OF AN AGRICULTURAL ENTERPRISE

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Abstract: Introduced audit in business and management of an agricultural enterprise can contribute to improving the management of the enterprise. This can reduce the risk to the top management of an agricultural enterprise. Management should be seen as an organ of the enterprise which is constantly looking for improvement of the management of the enterprise. The processes for establishing audit mechanisms should serve to improve the overall management of the agricultural enterprise. Audit can provide full support to management. The authors point out that their contribution in this paper is primarily aimed at identifying the first stage in the process of forming an audit control mechanism in the company, more specifically, the stage of preparation of the audit report submitted to top management and on the basis of which it further makes management decisions.

Key words: *audits, process management, agriculture*

INTRODUCTION

Farm management requires top management to find new innovative approaches that can help them make important business decisions [1], all with a view to making valid business decisions in agricultural businesses, [2] which can generate many benefits [3] in business.

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Agricultural businesses should use in their regular operations the various analyzes applied by auditors in their work [4], as this generally improves the work of the entire agricultural sector [5], [6], [7].

The audit of an agricultural enterprise begins with the design and preparation of an audit report for performing the audit work in the enterprise [8], [9]. This practically means that the practical functioning of the agricultural enterprise can be improved [10], [11], [12] if the audit reports are properly designed by the auditor.

All audit processes should respect processes based on the standardization of top management [13]. The auditor's behavior thus adopted results in a change in the overall behavior within the branches, that is, a change in socio-economic behavior within the economy as a whole [14].

Therefore, it can be observed that it is important for the audit business to form properly started and prepared audit reports in the company [16], [17], [18].

MATERIAL AND METHODS

The authors used generally accepted models of management in an agricultural enterprise to produce the work, which were based on the use of top management reporting by highly professionally trained personnel, more specifically by audit personnel.

Audit should be seen as an aid to top management in agricultural enterprises, and in this paper the authors draw attention to the importance of using auditors' reporting. In this regard, they have provided a possible and useful model for the sequence of events in agricultural companies, which is presented by the author in Figure 1 in this study, where the importance of audit reporting is emphasized.

Modern business requires modeling that involves innovative approaches by top management, which requires new approaches, which is achieved by a greater degree of application of the audit profession.

In this paper, the authors emphasize the importance of implementing audit reporting so as to improve substantially the achievement of job improvements, but also with the reduction of possible operational risks in the regular operations of a large number of agricultural enterprises.

RESULTS AND DISCUSSION

The authors point out that audit as a model of the method of improving the performance of an agricultural enterprise is an important factor business success in the operation of the agricultural enterprise itself. Audit at the stage of preparation of audit reporting in agricultural enterprises should include three parts:

- Audit report functions;
- the types of audit reports and their alternatives;
- Guidance on the structure and content of audit reports.

The audit report should provide the top management of the agricultural enterprise with the confirmation of the adequacy of the system under review as well as the basis for the overall confirmation of the adequacy of the internal control system communicated to the management through the report.

It is very important to keep in mind that the audit report is the only tangible product of the audit and, as such, it is a "showcase" of the internal audit. It represents the sum of the planning, time and effort invested in a single audit and reflects the quality and thoroughness of the audit.

The quality of the report will significantly affect the image that the organization's management will have of internal audit. An inadequate report can invalidate both the best audit work and the best conclusions. In addition, the report may adversely affect the reputation and status of the internal audit.

The purpose and functions of the audit report.

The main objectives of the audit report are:

- report on the problems identified and the causes of those problems; explain the effects and consequences of these problems and quantify them where necessary;
- to measure performance and to identify areas where greater efficiency and effectiveness can be achieved and loss eliminated;
- convince management of the need for change;
- propose practical and cost-effective solutions;
- Provide a basis for monitoring the implementation of appropriate measures.

There are three basic functions of an audit report. Firstly, the report is a document that should encourage action - a report that does not encourage action is a waste of time for everyone involved in the audit. In order to result in appropriate action being taken, the report should provide the user with a concise and objective assessment of controls in the area under review and highlight any significant weaknesses identified.

The report should also report on the impact of these weaknesses on the level of controls. Also, a report to the management indicates that something needs to be done about this:

- through explaining the risks,
- Where possible, quantify those risks and any potential benefits.

Secondly, the report is a formal, permanent record of the audit work performed and the conclusions obtained, as well as the level of controls that exist in a particular area at a particular time. Finally, a good report, demonstrating the professionalism and competence of the auditor, testifies to the objectivity and independence of the internal audit and demonstrates that the auditors can help improve efficiency and effectiveness.

A general management model based on the author's previous point of view is given in the form of a general model by the representation of Figure 1 by the author.

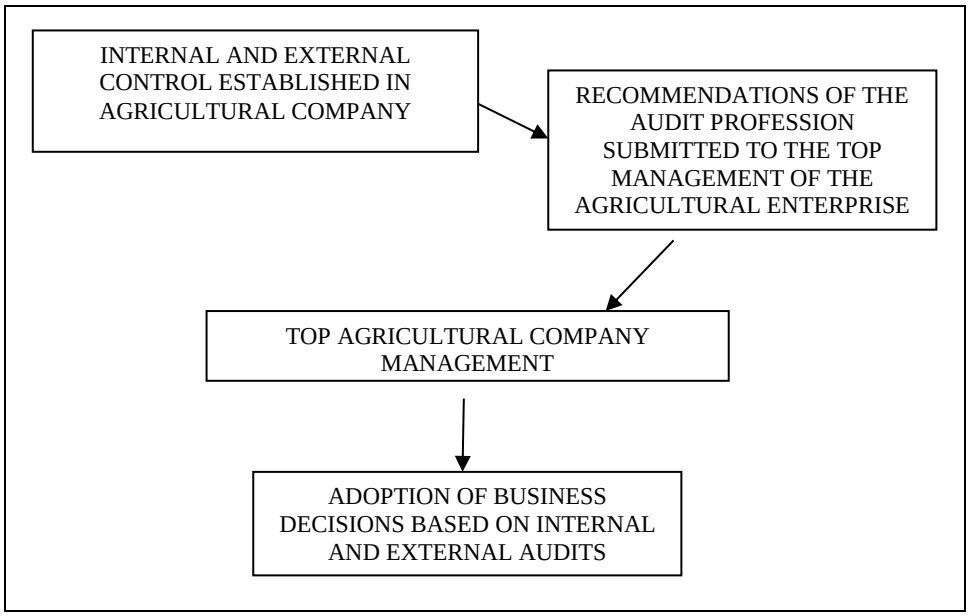

Fig. 1. Model of harmoniously introduced audit model in an agricultural enterprise based on top management decision making with respect to the recommendations of the audit profession

The report, as a formal record of the results of the audit, should be made in writing. There are two basic types of audit reports-the Standard Report and the Audit Memorandum.

A standard report is the type of report that is most commonly used. It consists of three main parts: a summary, an action plan (action plan) and a detailed report.

The MOU is usually shorter than the standard report and serves:

- For prompt and specific reviews carried out at the request of management to obtain information on the results of subsequent audits;
- when only minor audit findings emerge;
- as a transitional report in longer audits.

As an alternative to the audit report, there is also the possibility of an oral presentation, which entails a formal presentation of the audit findings, as well as a discussion of the measures that management should take. The advantages and disadvantages of reports and presentations are presented in the following table. The authors gave an example of the presentation method in Table 1.

Table 1. The method that implements the presentation in reporting to the top management of an agricultural enterprise

Presentation method	*Advantages*	*Deficiency*
Presentation	*Interactive* *Flexible* *Easier acceptance* *Helps to consider difficult questions and solutions* *May increase the chance of enforcement* *Contributes to focusing on priority issues* *Internal audit can influence the action taken*	*Not all evidence can be presented* *It can lead to difficulties in presenting complex data which can lead to misunderstandings* *Presentation skills and active involvement of two people are required* *Good preparation is necessary* *Possibility of dominance of one person or a particular problem* *The user can still request a report*
Standard Report	*Good for detailed reporting and complex data* *It can provide general information and context* *The evidence is immediately available to the reader* *Some users find reports more authoritative*	*They require more preparation time* *Long reports can remain unread until the end* *Sometimes hard to accept* *They may be untimely presented due to delays in preparation*

The internal audit manager should define the precise structure of the audit report. It is important that every organization has a distinctive reporting style. This helps managers to use and understand audit reports more easily, and helps create an image of the internal audit service.

Standard audit reports should usually include the following:

- Report cover / cover;
- The content;
- Summary;
- Activity plan / Recommendation proposal;
- Detailed report;
- Attachments / Annexes.

The audit memorandum includes:

- Introduction;
- Conclusion;
- A series of separate paragraphs, where detailed findings and recommendations have adequate headings.

The following are instructions on the content of each chapter / section in the standard audit report.

The cover/cover of the report should include the title of the report, date of preparation and number of the report.

Some audit services have a logo on the front page/cover. It would be a good idea to consider using different cover colors for different types of revisions (systems, VFM value, etc.).

CONCLUSIONS

In this paper, the authors emphasized the importance of drawing up an audit report in the ordinary course of business of an agricultural enterprise, which should be applied by top managers of enterprises in order to achieve better business results.

The contribution of the author is reflected in the highlighting of a model that respects the movement of top management's business decision-making while respecting the auditing profession.

In addition, the authors highlighted the general model of implementation of multiple types of audit report that can serve more agricultural enterprises in the ordinary course of business as well as the structure of the audit report itself.

The application of the structure of the audit profession in reporting is of great importance and the authors of the paper have highlighted the basic possible structures of the report.

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ZNAČAJ PRIPREME REVIZIJSKOG IZVEŠTAJA ZA TOP MENADŽMENT POLJOPRIVREDNOG PREDUZEĆA

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Sažetak: Uvedena revizija u poslovanje i upravljanje poljoprivrednog preduzeća može da doprinese poboljšanju upravljanja preduzeća. Time se može smanjiti rizik po poslovanje top menadžmenta poljoprivrednog preduzeća. Menadžment treba posmatrati kao organ preduzeća koji je u stalnom traganju za poboljšanjem upravljanja preduzeća. Procesi uspostavljanja revizijskih mehanizmama treba da posluže poboljšanju ukupnog upravljanja poljoprivrednog preduzeća. Revizija može da pruži punu podršku menadžmentu. Autori ističu da je njihov doprinos u ovom radu pre svega usmeren na utvrđivanje prve faze u procesu formiranja revizijskog kontrolnog mehanizma u preduzeću, preciznije istaknuto, reč je o fazi pripreme revizijskog izveštaja koji se dostavlja top menadžmentu i na osnovu kojeg on dalje donosi odluke vezane za upravljanje.

Ključne reči: *revizija, upravljanje procesima, poljoprivreda*

Prijavljen: *Submitted:*	25.12.2019.
Ispravljen: *Revised:*	05.05.2020.
Prihvaćen: *Accepted:*	30.05.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 28 – 36

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 28 – 36

UDK: 631.372:621.879

Originalni naučni rad
Original scientific paper
doi : 10.5937/PoljTeh2002028K

ANALIZA UZROKA POJAVE OTKAZA SUS MOTORA I PREDLOG ZA NJEGOVO OTKLANJANJE

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Sažetak: Posle nastanka otkaza motora sus preduzete su odredjene mere za njegovo otklanjanje. Po sprovodjenju tih mera opet je došlo do pojave otkaza motora po istom mehanizmu nastanka. U radu je rasvetljena problematika nastanka neispravnosti na motoru, ustanovljene uzročno-posledične veze i predložene mere za otklanjanje uzroka pojave otkaza.

Ključne reči*: motor sa unutrašnjim sagorevanjem, otkaz, održavanje.*

UVOD

Na motoru Caterpillar USA tip 3126, sa brojem BEJ12686, radne zapremine 7200 cm^3 i snage 168 kW (slika 1), koji je ugrađen u drobilicu za drvo proizvođača Vermeer Mfg. Company, tip BE 2000XL sa identifikacionom oznakom 1VRZ1S20171000278 (slika 2), došlo je do pojave otkaza. Usledio je pokušaj otklanjanja tog otkaza. Po završetku svih sprovedenih postupaka održavanja koji su imali za cilj vraćanje motora u ispravno stanje, došlo je vrlo brzo do ponovne pojave otkaza, i to na isti način.

Neke od dilema koje su nastale posle ponovnog otkaza motora su:

1. Šta je prouzrokovalo pojavu prvog otkaza motora;
2. Po kom mehanizmu je nastao prvi otkaz;
3. Šta je prouzrokovalo pojavu drugog otkaza motora;
4. Po kom mehanizmu je nastao drugi otkaz;
3. Da li su napravljene greške tokom eksploatacije mašine u koju je bio ugrađen motor;

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4. Da li su napravljene greške tokom održavanja mašine u koju je bio ugrađen motor;
5. Da li su napravljene greške tokom popravke motora posle pojave prve havarije.

U ispitivanju predmetne problematike, i davanju odgovora na nastale dileme, autori rada su se aktivno uključili i došli do odgovora koji će biti prezentovani u radu.

Cilj rada je rasvetliti problematiku nastanka neispravnosti na konkretnom motoru, ustanoviti uzročno-posledične veza i predložiti mere za otklanjanje uzroka pojave otkaza.

OBJEKAT ISPITIVANJA

Predmet analize je pogonski motor proizvodnje Caterpillar USA tip 3126, radne zapremine 7200 cm^3 i snage 168 kW (slika 2), a koji je ugrađen u drobilicu za drvo proizvođača Vermeer Mfg. Company, tip BE 2000XL (slika 1).

Slika 1. Drobilica za drvo Vermeer BC 2000XL
Figure 1. Wood crasher Vermeer BC 2000XL

Slika 2. Pogonski motor Caterpillar tip 3126
Figure 2. The Engine of Caterpillar 3126

TEHNIČKO STANJE POGONSKOG MOTORA DROBILICE VERMEER BC 2000 XL POSLE DRUGE HAVARIJE

Stanje pogonskog motora Caterpillar tip 3126, posle druge havarije, je:

- Drobilica za drvo proizvođača "Vermeer Mfg. Company" tipa BE 2000XL, pre ove analize radila je 1093 časova;
- Na bloku motora nema vidnih oštećenja;
- Oštećena je bregasta osovina na mestu šetog izduvnog ventila (slike: 5, 6);
- Pohabane su, i postoji veliki zazor između klackalice i njenog rukavca šestog izduvnog ventila koji je doveo do mogućnosti aksijalnog pomeranja klackalice (slike: 11,12);
- Oštećene su dodirne površine nosećeg dela "klackalica" i "glave" motora na delu klackalica ventila šestog cilindra (slike: 8,9,10);
- Oštećeni zu prateći delovi razvodnog mehanizma: nosač rolnice podizača šipke izduvnog ventila na šestom cilindru polomljen (slika 16), rolnica podizača šipke izduvnog ventila na šestom cilindru ispala i oštećena (slika 15), osovinica rolnice podizača šipke izduvnog ventila na šestom cilindru ispala i oštećena (slika 16);

- Sedište izduvnog ventila na šestom cilindru ne postoji - ispalo je (slika 14);
- Polomljen je šesti izduvni ventil na dva mesta - kod pečurke ventila i kod osigurača u zadnjem delu ventila (slike: 18, 19, 20);
- Deformisan je podizač izduvnog ventila šestog cilindra (slika 17);
- Oštećene su lopatice turbine motora polomljenih isitnjenim delovima (slika 22);
- Oštećeno je čelo klipa šestog cilindra (slika 14);
- Oštećen je brizgač šestog cilindra na prednjem delu (slike: 22, 23).
- Klipnjača klipa šestog cilindra nije oštećena (slika 21).
- Zupčanik bregastog vratila nije oštećen (slika 3).

Slika 3. Bregasta osovina, osovinica klackalica sa klackalicama i nosač rolnica motora Caterpillar tip 3126 -celokupan izgled

Figure 3. Camshaft, rocker arm with swingarms and Caterpillar 3126 engine roller beaing - overall layout

Slika 4. Blok pogonskog motora proizvodnje Caterpillar tip 3126 - pogled sa boka

Figure 4. Caterpillar production engine block - side view

Slika 5. Bregasta osovina pogonskog motora Caterpillar tip 3126

Figure 5. Caterpillar 3126 Camshaft Camshaft - Overall

Slika 6. Bregasta osovina motora Caterpillar 3126-oštećenje brega šestog izduvnog ventila-pogled odozgo

Figure 6. Caterpillar 3126 Camshaft - Six Exhaust Valve Camshaft Damage - Top View

Slika 7. Oštećene površine nosača klackalica koje dodiruju glavu iznad šestog cilindra motora Caterpillar

Figure 7. The damaged surfaces of the rocker arms that touch the head above the sixth cylinder

Slika 8. Površine nosača klackalica koje dodiruju glavu motora proizvodnje Caterpillar

Figure 8. The rocker arm surfaces that touch the Caterpillar 3126 engine head

Slika 9. Oštećena treća površina nosača klackalica koja dodiruje glavu iznad šestog cilindra, motora proizvodnje Caterpillar 3126

Figure 9. The damaged third surface of the rocker arm that touches the head above the sixth cylinder, Caterpillar 3126 engine

Slika 10. Oštećena treća površinu nosača klackalica koja dodiruje glavu iznad šestog cilindra motora

Figure 10. The damaged third surface of the rocker arm that touches the head above the sixth cylinder,motor engine

Slika 11. Neoštećena druga površinu nosača klackalica koja dodiruje glavu iznad šestog cilindra, motora Caterpillar 3126 - radi upoređenja sa oštećenom površinom

Figure 11. A intact second surface of the rocker arm that touches the head above the sixth cylinder, Caterpillar 3126 engine - for comparison with the damaged surface

Slika 12. Klackalica koja dodiruje glavu iznad šestog cilindra motora drobilice za drvo - povećan zazor koji omogućuje i aksijalno pomeranje i klaćenje klackalice šestog izduvnog ventila

Figure 12. The rocker arm that touches the head above the sixth cylinder of the wood crusher - enlarged clearance allowing both axial movement and rocking of the rocker of the sixth exhaust valve

Slika 13. Oštećeno ležište rolnice koja usmerava kredanje šipke podizača šestog izduvnog ventila motora

Figure 13. A damaged roll bearing that directs the choke of the sixth exhaust valve of the engine

Slika 14. Oštećena glava motora, oštećeno sedište ventila i polomljen izduvni ventil na šestom cilindru motora

Figure 14. View of damaged engine head, damaged valve seat and broken exhaust valve on sixth engine cylinder

Slika 15. Oštećena rolnica koja usmerava kredanje šipke podizača šestog izduvnog ventila motora drobilice

Figure 15. The damaged roll directing the chalk rod lift of the sixth exhaust crusher engine of a wood shredder

Slika 16. Oštećena osovinica rolnice koja usmerava kredanje šipke podizača šestog izduvnog ventila motora drobilice za drvo

Figure 16. A damaged roll axis that directs the chalk rod lift of the sixth exhaust crusher engine of a wood shredder

Slika 17. Oštećeno – polomljeno stablo (obostrano) izduvnog ventila na šestom cilindru pogonskog motora

Figure 17. Damage view - broken on both sides of the exhaust valve tree on the sixth cylinder of the drive engine

Slika 18. Oštećen - polomljen deo stabla izduvnog ventila na šestom cilindru sa svojim osiguračem u svom repnom delu pogonskog motora

Figure 18. A damaged - broken part of the exhaust valve tree on the sixth cylinder with its fuse in its tail section of the drive engine

Slika 19. Deformisana i nedeformisana šipka podizača izduvnog ventila na šestom cilindru motora

Figure 19. Deformed exhaust valve pickup rod on engine sixth cylinder next to undeformed

Slika 20. Vođica izduvnog ventila na šestom cilindru motora sa delom polomljenog stabla

Figure 20. Exhaust valve guide on a six cylinder engine with part of a broken tree

Slika 21. Klip i klipnjača šestog cilindra motora drobilice za drvo

Figure 21. Piston and piston rod of a six-cylinder wood shredder engine

Slika 22. Oštećene lopatice turbine motora drobilice za drvo

Figure 22. Damaged wood shredder turbine engine blades

Slika 23. Brizgač - injektor šestog cilindra motora drobilice za drvo

Figure 23. Injector - injector of the sixth cylinder of the crusher engine for wood

Slika 24. Oštećen brizgač - injektor šestog cilindra motora drobilice za drvo

Figure 24. Damaged Injector - Six Cylinder Engine Injector for Wood Crusher

REZULTATI ISTRAŽIVANJA I DISKUSIJA

Do konstatovane havarije na istom motoru Caterpillar USA tip 3126, došlo je u kratkom vremenskom roku zbog:

- Posle nastanka prve havarije, nije izvršena potrebna detaljna analiza uzroka nastanka havarije;
- Nije izvršeno rastavljanje svih delova motora posle prve havarije i nisu otklonjeni svi uzroci koji su doveli do pojave prve havarije;

Na nastalu havariju drobilice za drvo uticali su brojni uzroci: neadekvatno održavanje, velika opterećenja pri radu, dotrajalost mašine,

U želji da se zaključak donese isključivo na osnovu objektivno utvrđenih i na nauci i struci zasnovanih činjenica [1,2,3,4], izvršena je detaljna analiza uzročno-posledičnih veza [1]. U istoj nameri, detaljno je snimljeno postojeće stanje predmetnog motora i drobilice za drvo u koju je on bio ugrađen. Izvršena je i kompletna detaljna analiza uzročno-posledičnih veza u radu drobilice za drvo i motora u njoj [1,2,3] i na osnovu svega toga daje se zaključak i mišljenje:

1. Drobilica za drvo proizvođača Vermeer Mfg. Company, tip BE 2000XL sa identifikacionom oznakom 1VRZ1S20171000278 (proizvedena posle 2007 godine. prema podacima iz identifikacione oznake mašine, broj 7 na desetoj poziciji). Broj časova rada drobilice za drvo, na dan 18.05.2019.god. je 1093 časova rada (slika 5).

2. Drobilica za drvo proizvođača Vermeer Mfg. Company tip BE 2000XL sa identifikacionom oznakom 1VRZ1S20171000278 ima fabrički ugrađen motor Caterpillar USA tip 3126, sa brojem BEJ12686, radne zapremine 7200 cm^3 i snage 168 kW.

3. Redosled nastanka havarije motora Caterpillar USA tip 3126, je:

Usled povećanja zazora u sklopu klackalica izduvnog ventila šestog cilindra i osovine klackalica (slika 12), ali i usled nedovoljno zategnutih zavrtnjeva koji pritežu klizne ležajeve klackalice sa glavom motora (vidljive su velike neravnine usled habanja tih površina na slikama: 7,8,9,10) došlo je do većeg aksijalnog pokretanja - klaćenja klackalice (što se nije smelo dozvoliti).

To aksijalno kretanje klackalice, uz rotaciono kretanje (koje je jedino dozvoljeno u ovom sklopu) dovelo je do pucanja zadnjeg dela izduvnog ventila na šestom cilindru zajedno sa svojim osiguračem (slika 18).

Usled pucanja zadnjeg dela izduvnog ventila na šestom cilindru zajedno sa svojim osiguračem, šipka podizača izduvnog ventila šestog cilindra nije bila u stanju da da podiže zadnji kraj klackalice ovog ventila jer je došlo do pojave velikih otpora njegovom kretanju, te je zbog toga došlo do njenog krivljenja (slika 17).

Usled krivljenja šipke podizača izduvnog ventila šestog cilindra došlo je do pucanja kliznog ležišta osovinice na kojoj se nalazi rolnica koja ima zadatak "vođenja" ove šipke (slike: 17).

Posle pucanja kliznog ležišta osovinice na kojoj se nalazi rolnica koja ima zadatak "vođenja" šipka podizača izduvnog ventila šestog cilindra, došlo je do ispadanja osovinice rolnice (slika 16) iz ležišta, i same rolnice (slika 15) sa osovinice i do njihovog upadanja u prostor između bloka motora i brega izduvnog ventila šestog cilindra što je dovelo do velikog oštećenja ovog brega (slike: 5,6,7), jer je motor i dalje radio (tada sa pet cilindara), a bregasto vratilo se okretalo sve do konačnog isključivanja mašine jer se ono okreće - pogoni preko svog zupčanika (slike: 5) koji nije oštećen.

Veliko oštećenje brega izduvnog ventila šestog cilindra (slike: 5,6,7), ali i rolnice (slika 15) i njene osovinice (slika 16), upućuju na zaključak da drobilica za drvo, posle havarije, nije odmah isključena.

Sve što se dalje dogodilo, po pitanju havarije ovog motora, posledica je prethodno navedenih pojava i događaja.

Pošto je motor i dalje radio sa pet cilindara, brizgač-injektor je i dalje ubacivao gorivo, koje nije moglo da se pali, u šesti cilindar motora i to je dovelo do pojave gustog dima iz izduvnog sistema drobilice.

Pošto se izduvni ventil nije zaglavio (kao kad se dogodila prvi put havarija na ovom motoru), on je krenuo prema klipu i u direktnom kontaktu sa klipom polomljena je njegova pečurka(slike 14,18,19), što pri normalnom radu motora nikada do toga ne bi moglo da dođe. Pri tom je došlo i do loma sedišta ovog ventila (slika 14).

Polomljeni delovi pečurke izduvnog ventila šestog cilindra, kao i delovi sedišta ovog ventila, izazvali su oštećenje vrha injektora-brizgača (slika 22,23), ali i čela klipa šestog cilindra (slika 14) i skoro neprimetno oštećenje cilindra u gornjem delu što ne utiče na dalju upotrebnu vrednost šestog cilindra.

Polomljeni delići sedišta ventila i pečurke ventila uleteli su u prostor turbine i izazvali njeno oštećenje (slika 22).

Na pojavu otkaza-havarije motora nije uticala glava motora. Obrazloženje je:

- Gornji deo stabla izduvnog ventila (slike: 18,19) ostalo u svojoj vođici (slika 20), bez ikakvih problema je izvučen iz svoje neoštećene vođice.

Na tom delu nije oštećeno ni stablo ventila niti njegova vođica.

Prethodno navedene činjenice upućuju na zaključak da nije bilo neophodno zameniti vođicu izduvnog ventila šestog cilindra i da njeno nezamenjivanje nije doprinelo pojavi havarije motora.

- Da je glava motora bila oštećena (naprsla) na čelo klipa bi dospela tečnost za hlađenje, tako da bi čelo klipa imalo sasvim drugu boju-plavičastu, a došlo bi i do njegovog nagorevanja, kao i nagorevanja cilindra motora. U konkretnom slučaju do toga nije došlo (slika 21) jer čelo klipa ima čistu-fabričku boju, a na cilindru nema nikakvih termičkih promena.

Prethodni opis upućuje na zaključak da nije bilo neophodno sprovesti tzv. hidro-test glave motora, i da glava motora nije doprinela da dođe do havarije motora.

U zaključku ovog rada može se navesti da odgovornost za nastalu havariju motora "Caterpillar" USA tip 3126, broj motora BEJ12686, koji je ugrađen u drobilicu za drvo proizvođača "Vermeer Mfg. Company" tip BE 2000XL, sa identifikacionom oznakom 1VRZ1S20171000278, treba pripisati serviseru koji nije utvrdio uzrok pojave prve neispravnosti na motoru, a samim tim nije ni sproveo potrebne postupke održavanja motora (prvenstveno podešavanje razvodnog mehanizma motora).

Istraživanjem uzroka pojave havarije motora "Caterpillar" USA tip 3126, došlo se do zaključka da pri sprovođenju postupaka održavanja motora neophodno je pravilno sprovesti postupke utvrđivanja tehničkog stanja motora (primenom objektivnih dijagnostičkih metoda), lokalizovati neispravnost, izvršiti detaljnu analizu uzročno-posledičnih veza, a potom pristupiti otklanjanju nastale neispravnosti.

U konkretnom slučaju nije se postupilo po tehničko-tehnološkim pravilima, tako da je iz tog razloga došlo do pojave havarije motora, i drugi put, na isti način, i po istom mehanizmu, i sa istim posledicama.

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ANALYSIS OF THE CAUSES OF IC ENGINE FAILURE AND PROPOSAL FOR ITS REMOVAL

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Abstract: After the failure of the internal combustion IC engine, certain measures were taken to eliminate it. Following the implementation of these measures, motor failure again occurred following the same mechanism of occurrence. The problem of occurrence of malfunction on the motor is explained in the paper, the cause and effect relationships are established, and the proposed measures for eliminating the cause of failure occurrence.

Key words: *engine, failure, maintenance*

Prijavljen: *Submitted*:	23.12.2019.
Ispravljen: *Revised*:	15.02.2020.
Prihvaćen: *Accepted*:	25.04.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 37 – 44

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 37 – 44

UDK: 338.43.1.

Originalni naučni rad
Original scientific paper
doi: 10.5937/PoljTeh2002037R

APPROVAL OF FINANCIAL ANALYSIS IN THE MANAGEMENT OF AGRICULTURAL COMPANY

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Abstract: An agricultural company is a living organism that tends to evolve. In order to achieve this, it is necessary to implement adequate planning, establish controls and analytical procedures that are used in all aspects of the business. For decades, agricultural companies have been dominated by accounting analysis, which included, above all, adequate monitoring of the process through analysis in the financial statements, and in particular the analysis of data relevant to the operation of any enterprise. The application of modern accounting analysis should provide the management of the company with a wide range of opportunities regarding the continuous growth and development of the company in accordance with the set goals. However, this is not enough. Modern financial management does not rule out an accounting approach, but it does introduce a complete observation of the financial situation in the company, fair valuation of the assets of the company, realistic financial reporting, through the implementation of a realistic financial report obtained by the top management by the sector managers and departments in the company.

Key words: *short food supply chain; distribution; sustainability; information*

INTRODUCTION

Until 20 years ago, financial analysis was exclusively related to accounting analysis as a term often used in the professional circles, denoting an essential analysis of the company's business [1], [2], [3], [4], [5].

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The application of modern accounting analysis has, over the decades, yielded certain results that were not sufficiently sufficient to effectively manage companies [6], [7], [8], [9], [10], especially when they were largely traded and when realistic valuation of the company was required.

Basically, the financial statements change and are consolidated.

This was particularly favored by the increasing and significant harmonization of international accounting standards. They recognize the five basic financial statements: balance sheet, income statement, cash flow statement, statement of changes in equity and notes to the financial statements.

Based on this structure, contemporary analysis identifies the aforementioned financial statements as a primary subject of interest and can be defined as a set of measures, actions and activities that aim to put the numerical information in the financial statements in an appropriate relationship with the purpose of providing new numerical (real) value. Some outsiders consider such an approach to be a specific indicator of the quality (adequacy) of an enterprise.

This study presents not only an approach that respects the concept of accounting analysis but also an approach that analysis can take to the overall business of a company. Essential attention is focused on: analysis of financial statements, its significance, comparative and summary financial statements, as well as comparative and process analysis of financial statements.

All applicable procedures should be used to improve the business [11], [12], [13], [14], [15], primarily by the continuous and systematic monitoring of the overall process that accompanies the financial reporting process.

MATERIALS AND METHODS

For the preparation of this paper, the author has placed the focus of research on financial analysis as a basis for reporting to top management of an agricultural enterprise. The research involved, first and foremost, the theoretical gathering of valid information on the basis of which it is possible to make a theoretical model of the practical application of a given research goal that the author has set for himself. This is done in the view given in Figure 1-2.

In the second part of the research, the author gave an overview of the top management's real reporting to the state authorities in the form of a specific company balance sheet (Table 1) and presented a table 2 of the balance sheet changes over the course of several years with a presentation of the size changes.

The aim of applying the presented methods in this paper was to give a model that would take into account possible reporting, that is, to put top management reporting in the focus of reporting as possible and realistically acceptable in the real economy of an agricultural enterprise.

RESULTS

In order to ensure adequate conditions for the development of a company, it must have good and modern organized management in all its parts of the company.

In this context, the importance of implementing a business analysis of a company is dominant. It can provide information that is relevant to modern enterprise management, which essentially means good management of the enterprise resources. In doing so, the overall analysis seeks to fully cover all relevant data and information, be it monetary or material information that is generated within the enterprise and that is collected within the company. The analysis of financial statements is primarily focused on the value or financial information presented in the financial statements that are submitted to top management for decision making. The analysis of financial statements focuses primarily on quantitative financial information and is therefore often referred to as quantitative financial analysis.

The three most important areas are generally thought to dominate the origins and development of financial analysis. The most important areas in almost every company are: financial management, management accounting and financial accounting. The analysis of the financial statements strives for and directs its outlook on the future, highlighting those aspects of business that are relevant to market survival, and above all are the safety and efficiency of the business, which is of utmost importance in the functioning of an agricultural enterprise. Viewed only from a financial standpoint, business analysis for the needs of the manager must include an analysis of financial results, financial conditions, financial structure and changes in financial structure.

Analysis of financial statements can be defined as the process of applying various analytical tools, methods and techniques by which the data from financial statements is transformed into usable information, relevant to the modern management of the company.

Common analytical tools and methods generally used in standard financial statement analysis are:

- comparative financial statements,
- considering the tendency of change through a number of relevant indices;
- summary financial statements;
- indicator analysis;
- special non-standard analysis.

The importance of financial statement analysis is seen in the context of modern business management and agricultural enterprise development. The analysis precedes the management process. Any quality and sound financial plan must take into account the desirable characteristics of the company on the other hand and its potential weaknesses.

The primary task of analyzing financial statements is actually to identify good performing companies in order to reap the full benefits of the company, but also to appreciate the weaknesses of the company so that corrective action can be taken. The analysis of the financial statements therefore provides information as a basic input from which to reflect and judge business activities for the purpose of making appropriate decisions.

The author points out that apart from the modern management of the company, other participants also appear, who want to obtain relevant information for decision making in the work of their legal entities. The author presented the possible scheme of participants in the form of picture number 1.

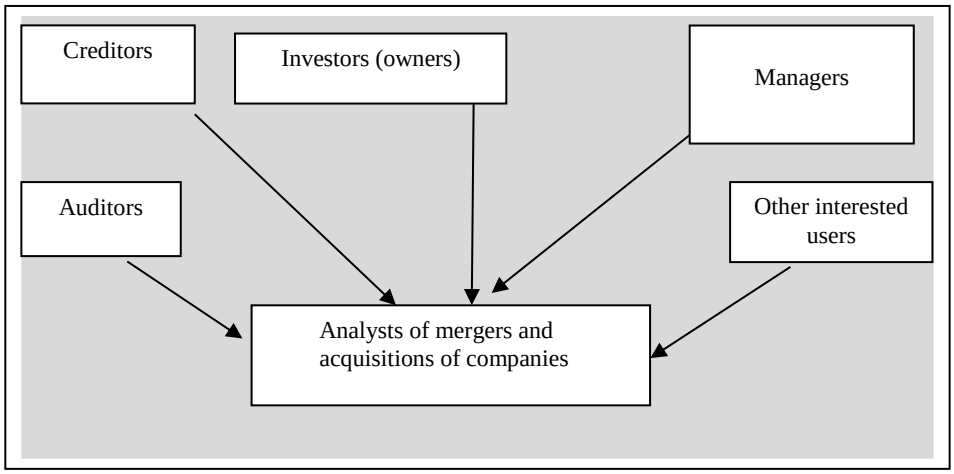

Figure 1. Outline of possible subjects interested in obtaining essential information necessary for modern decision-making and management.

Case study presentation of a practical balance sheet of an enterprise that is essential for making valid management decisions.

The author gives an overview of the actual balance of the company, to illustrate the importance of data for financial and any other analysis in the company. For a better understanding of the foregoing, the author provided an overview of the actually completed balance sheet of the companies whose generals are not listed, as well as the business year for which the views were given.

The presentation itself is presented in Table No.2, as well as the Financial Statement Analysis, which enables comparisons of data over a longer period to identify trends and dynamics of changes in certain balance sheet items Table No. 1.

Table 1. Balance sheet changes over several years

Tendencies of changes in the income statement.

Status at 31. 12.					
Business year	*1*	*2*	*3*	*4*	*5*
NETO SALES	*100*	*103*	*145*	*173*	*222*
GROSS PROFIT	*100*	*102*	*104*	*105*	*142*
NETO PROFIT	*100*	*101*	*105*	*117*	*166*

Table 2. View of the actual balance sheet of a real enterprise with reported sizes that truly reflect the business of an unnamed company

Comparative Balance Sheet				
	Status at 31. 12.		*Ammount of increase (decrease)*	*Percentage of increase (decrease)*
	previous business year	*current business year*		
ASSETS (in 000 RSD)				
PROPERTY, PLANTS AND EQUIPMENT:				
- land	*4.300*	*4.520*	*220*	*5,1*
- facilities	*72.540*	*72.540*	*-*	*-*
Less: value adjustment	*(29.196)*	*(30.696)*	*1.500**	*5,1*
- equipment	*16.717*	*18.907*	*2.190*	*13,1*
Less: value adjustment	*(7.840)*	*(7.980)*	*140**	*1.8*
TOTAL PROPERTY, PLANTS AND EQUIPMENT	*56.521*	*57.291*	*770*	*1,4*
LONG-TERM INVESTMENTS:				
- Investments in ordinary shares	*6.000*	*6.000*	*_____-*	*_____-*
CURRENT ASSETS				
- cash	*6.574*	*5.368*	*(1.206)*	*(18,3)*
- securities	*1.570*	*3.090*	*1.520*	*96,8*
- claims (net)	*32.936*	*35.382*	*2.446*	*7,4*
- supplies of goods	*50.434*	*62.582*	*12.148*	*24,1*
- subscription costs	*2.590*	*2.870*	*280*	*10.8*
TOTAL CURRENT ASSETS	*94.104*	*109.292*	*15.188*	*16,1*
TOTAL ASSETS	*156.625*	*172.583*	*15.598*	*10,2*
LIABILITIES (in 000 RSD)				
SHAREHOLDERS 'EQUITY				
- preferred shares				
5% (nom. value10)	*500*	*500*		
- ordinary shares (nom. value 1)	*9.500*	*10.000*	*500*	*5,3*
- capital profit	*30.053*	*35.843*	*5.790*	*19,3*
- retained earnings	*47.657*	*57.207*	*9.550*	*20.0*
TOTAL SHAREHOLDERS 'EQUITY	*87.710*	*103.550*	*15.840*	*18,1*
LONG-TERM LIABILITIES:				
- mortgage bonds 8%	*28.000*	*25.000*	*(3.000)*	*(10,7)*
- unsecured bonds 10%	*-*	*5.000*	*5.000*	*∝*
TOTAL LONG-TERM LIABILITIES	*28.000*	*30.000*	*2.000*	*7.1*
CURRENT LIBILITIES:				
- payment invoices	*33.353*	*29.235*	*(4.118)*	*(12,3)*
- taxes	*2.425*	*3.040*	*615*	*25,4*
- other current liabilities	*2.137*	*3.758*	*1.621*	*75,9*
- current portion of long-term liabilities	*3.000*	*3.000*	*_*	*_*
TOTAL CURRENT LIBILITIES	*40.915*	*39.033*	*(1.882)*	*(4,6)*
TOTAL LIABILITIES	*68.915*	*69.033*	*118*	*0.2*
TOTAL PASSIVE BALANCE	*156.625*	*172.583*	*15.958*	*10,2*

DISCUSSION

The author emphasizes the importance that the management of an agricultural enterprise should take into account the basic characteristics of information that can be obtained by analyzing all parts of the company when preparing financial statements.

Obsolete or inaccurate information is useless, as is information that is true, but whose method of obtaining it is too complicated and expensive and therefore it is not desirable for the company to access it in such an economically unacceptable way. Therefore, management needs to find the optimal balance between all the attributes that characterize the information and the associated costs.

Only information created under these conditions, provided in a timely manner to top management, will have great practical value for making management's valid business decisions in managing an agricultural enterprise.

Part of the basic methods used in the analysis of financial statements is presented by the authors in this study, with the aim, among other things, to present real-world reporting on the example of a company in the balance sheets.

CONCLUSIONS

Financial reporting that involves the realistic preparation of financial statements is becoming increasingly important in the real operations of various companies. Financial reporting is used as a basis for conducting comparative analyzes, while summary financial statements are used to analyze the process.

This is especially true in manufacturing companies such as agricultural companies. The application of such financial reporting through comparative analysis can best be explained as a method of comparing an entity in two different periods.

Comparison requires certain prerequisites:

1. It is necessary to keep unique records in companies;
2. It is necessary to provide an equal time interval for the analysis;
3. The related data groups must be compared;
4. When comparing between companies, the size of the company, etc. must be taken into account.

The process analysis method is used to review the structure of a specific and complex subject of analysis, especially in the agricultural enterprises, especially in the summary financial statements, which the study author illustrated and illustrated in Table 1 and Table 2.

The general conclusion is that the use of this approach, as outlined in the study, is justified and necessary, especially in the production companies of such agricultural enterprises, as they are most likely to see the results of operations submitted in the form of financial reports to top management.

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UVAŽAVANJE FINANSIJSKE ANALIZE U UPRAVLJANJU POLJOPRIVREDNIM PREDUZEĆEM

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Sažetak: Poljoprivredna kompanija je živi organizam koja teži da se razvija. Da bi se to ostvarilo potrebno je implementirati adekvatno planiranje, uspostaviti kontrole i analitičke postupake koji se koriste u svim aspektima poslovanja.

U poljoprivrednim kompanijama decenijama unazad je dominirala računovodstvena analiza, koja je uključivala pre svega adekvatno nadgledanje procesa putem analize u finansijskim izveštajima a naročito analizu podataka koji su bitni za rad bilo kog preduzeća.

Primena savremenih računovodstvenih analiza treba da pruži rukovodstvu preduzeća širok spektar mogućnosti u pogledu neprekidnog rasta i razvoja kompanije u skladu sa unapred postavljenim ciljevima. Međutim to nije dovoljno, Savremeno finansijsko upravljanje ne isključuje računovodstveni pristup, ali uvodi celokupno posmatranje finansijske situacije u preduzeću, fer vrednovanje imovine preduzeća, realno finansijsko izvještavanje, putem primene realnog finansijskog izveštaja kojeg dobija sam top menadžment od strane rukovodioca sektora i odeljenja u preduzeću.

Ključne reči: *upravljanje, finansijska analiza, poljoprivredno preduzeće.*

Prijavljen: *Submitted:*	24.01.2020.
Ispravljen: *Revised:*	04.05.2020.
Prihvaćen: *Accepted:*	22.05.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 45 – 55

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 45 – 55

UDK: 666.95:691.55:719

Original scientific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002045B

FEASIBILITY OF USING SAWDUST ASH OF *Gmelina arborea* ROXB.,TREE IN ABIA STATE OF NIGERIA AS ADMIXTURE IN PRODUCTION OF CONCRETE

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***Abstract*:** *Gmelina arborea* Roxb.,is a rainforest tree that is found in tropical region. The study investigates the feasibility and effect on the properties of concrete by using sawdust ash as pozzolan produced from *Gmelina arborea* Roxb.,tree in Abia state. Concrete mix of 1:2:4 by volume batching and constant water to cement ratio of 0.6 were used. The slumps were 60, 70, 89, 60, 55 and 47mm at partial replacement of 0, 5, 10, 15, 20 and 25% respectively. The compressive strength at 28th day of curing for 0, 5, 10, 15, 20 and 25% were 27.67, 27.22, 21.22, 20.00, 18.89 and 18.33 N/mm^2 respectively. The research on the slump indicates that all the replacements have good workability to be categorized as true slump, with the 10% partial replacement having the highest workability. In addition, the compressive strengths developed at 28th day showed that the concretes developed good strength, which can increase with further age of curing because pozzolanic concrete develops late better strength and durability than ordinary concrete.

Keywords: *Gmelina arborea* Roxb., Sawdust Ash, Pozzolan, Concrete, Workability, Compressive Strength

INTRODUCTION

Concrete is a composite material containing coarse and fine aggregates, bonded together by cement paste. Cement paste is a combination of cement and water, based on the water-cement ratio used in the concrete mix design. Cement is a binding agent in concrete mix, and it is the reliable binder since its discovery.

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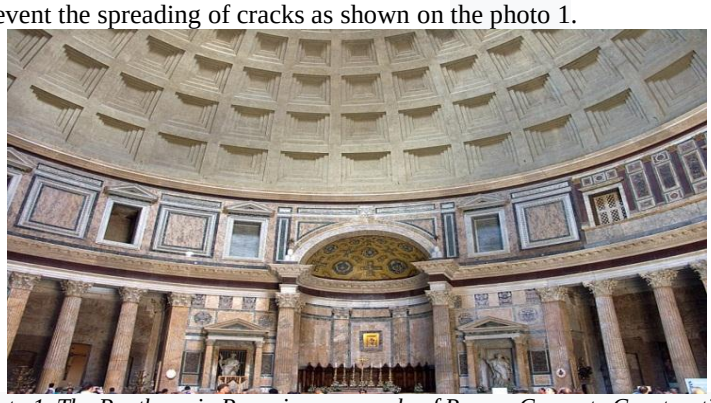
Portland cement is one of the types of cement used in construction industry, and it is classified as general purpose cement because of its numerous usages. It is widely used in developing countries.

Cement has deficiencies in some of its properties like setting time, workability in fresh concrete, compressive strength and durability in hardened concrete. Cement has some deficiencies in its usefulness, which are low workability of fresh concrete, compressive strength and durability. However, the production of cement is very expensive and causes pollution to the environment. The high cost of a bag of cement is caused by high capital intensive, high taxation of industry, fluctuations in power supply, policies of the government, high cost of transportation of cement etc. in order to achieve economic benefit in concrete production, the issue of high cost can be resolved if a partial replacement of cement with a cheap material that can blend with cement can be used as admixture in concrete batching and mixing. Materials that can be used as blended cement must be pozzolanic in nature or serve as superplasticizers.

Pozzolans are materials that can react with hydrated cement to form a cementitious compound. This cementitious compound reduces the permeability of concrete, thereby increasing the strength of concrete. Pozzolans have environmental, energy, economic and technical benefits than cement; hence its usefulness is very important in concrete production. According to [1], a material that meets minimum requirement of 70% of the sum of silica, alumina and iron oxide in composition meets the requirement to be used as pozzolan.

Researchers for several years are investigating into different materials that can replace or partially replace cement in concrete production. Pozzolans has been useful in concrete production since the period of Roman Empire with the use of roman concrete called opus caementicium, which is durable because it is incorporated with volcanic ash that can prevent the spreading of cracks as shown on the photo 1.



The photo 1. The Pantheon in Rome is an example of Roman Concrete Construction, [2].

There are two types of pozzolans, which are natural pozzolans (for example volcanic ash) and artificial pozzolans.

Artificial pozzolans can be divided into industrial and agricultural pozzolans. Many researches has been done by many researchers on agricultural residues to investigate their effect on concrete properties, such as corncob ash [3], sugar cain bagasse [4], groundnut shell ash [5], mollusc shell ash [6], Egg shell Powder [7] and rice husk ash [8, 9, 10 and 11].

Saw dust ash materials possess pozzolanic properties, they impact technical advantages to the resulting concrete and also enable larger quantities of cement replacement to be achieved [12]. The primary aim of this study is to explore the potential of sawdust ash produced from one of products called *Gmelina arborea* Roxb., tree in Abia state of Nigeria as a partial replacement of ordinary Portland cement by blending it with cement in concrete production and examining its basic properties, like the workability and compressive strength of the concrete produced. The picture of Gmelina tree is shown in figure 2.

The technical benefits of pozzolans in concrete like better workability with low water cement ratio, resistant of concrete to sulphate attack and chloride attack can be improved with the presence of good pozzolan in concrete production.

The photo 2. Gmelina arborea Roxb. *tree*

MATERIALS AND METHOD

Materials and Equipment

The materials that were used for the production of the concrete are: river sand, ordinary portland cement (OPC), saw dust ash from *Gmelina arborea* Roxb.,tree, borehole water, and granite. The equipment that were used are furnace, weighing balance, pycnometer bottle, density mould, compression machine, laboratory oven, mechanical sieve shaker, sieve brush, hand trowel, tamping rod, slump cone, curing tank, concrete cylindrical moulds, measuring tape, Sieve stack (British Standard) with receiver.

Test Method

A. **sieve analysis of sand**, gravel, cement and gmelina sawdust ash: In accordance with [13], river sand of size below 4.75mm was used as fine aggregate; also coarse aggregate of size below 40mm was used according to the recommended standard. The results of the sieve analysis on the aggregates are shown in tables 4.4 and 4.5 respectively.

The Ordinary Portland cement (Dangote, Brand) that was used was obtained from a local supplier at army check point along Ikot Ekpene road in Umuahia Abia State and it conformed to the requirements of [14]. The gmelina tree saw dust used for this study was obtained by sawing the tree, using sawing machine and collected in saw mill points at timber market Ahiaeke, Umuahia, Abia State, Nigeria as shown in plate 3. The Sample was carefully collected to avoid mixing the saw dust with sand. The collected sample was burnt into ashes and the saw dust ash (SDA) was ground after cooling using mortar and pestle. The yield was used to calculate the average specific gravity of the gmelina sawdust ash. The water used for the study was obtained from CEET bore hole, MOUAU. The water was cleaned and free from any visible impurities. It conformed to [15] requirements. Generally, water that is suitable for drinking is satisfactory for use in concrete.

The photo 2. Collection of Gmelina arborea Roxb*., Sawdust at Saw Mill Point*

B. slump of fresh concrete: Slump test is used to determine the workability of fresh concrete. The method for slump test of fresh hydraulic-cement concrete in accordance with [16] was used to carry out the concrete slump test.

C. water absorption and compressive strength of hardened concrete

Mix Proportion

Concrete mix of ratio 1:2:4 was used to achieve concrete grade of C25 according to [17],with the use of water to cement ratio of 0.6.

Casting, Curing and Testing

A. Water Absorption of Concrete after the Curing Period: The composites were made with materials having different water absorption rate, and bulk weight respectively.

The percentage absorption for the different sample replacement was then obtained and recorded according to the test method recommended by [18].

B. Procedures of compressive strength tests: [19] method for compressive strength tests were used for the concrete cubes mixtures to test all the concrete cubes.

Batching and casting were done with concrete mix of 1:2:4 at control level (0% partial replacement) and 5 to 25% partial replacement of OPC with the pozzolan (Gmelina sawdust ash) to form Portland Pozzolanic Cement (PPC).

The fresh concretes produced were used to fill the steel moulds of dimension 150x150x150mm to form concrete cubes, and de-moulding was done after 24 hours. The samples were allowed to undergo curing, and the samples were removed for testing. Concrete cubes of 150x150x150mm cured at 7 days interval were crushed to determine their strength using a compressive machine of 2000 kN capacity. Immerse in water, for a minimum of 5 minutes, those cubes which have not been cured in water or where the surfaces have been allowed to dry. The cubes were removed from the curing water tank for testing while they were still wet. Carefully, the cubes were centered on the lower platen and ensured that the loads were applied to the two opposite cast faces of the cube. Without shock, the load was applied and increased continuously at a nominal rate within the range 12 MPa/min. to 24 MPa/min. until no greater load could be sustained. Record the maximum load applied to the cube. The compressive strengths for the various concrete from control to the various replaced concrete partially replaced by sawdust were calculated and recorded as shown in table 15, using the expression

$$\text{Fcu} = \frac{crushing\ load(N)}{surface\ area(mm^2)} \text{ for the mean crushing load.}$$

RESULTS AND DISCUSSION

Specific Gravity and Sieve Analysis of the Constituent Materials

The average specific gravity of cement, sand, gravel and the sawdust ash used were 3.09, 2.65, 2.76 and 0.68 respectively. The results of sieve analysis of the aggregates are shown in table 1 and 2 respectively. The result was used to calculate fine aggregate Fineness Modulus (FM) = cumulative percentage retained up to standard sieve of size 150μm / 100 = (1.16+5.08+19.59+44.82+61.68+95.08)/100 = 2.27, which is within the acceptable limit set for FM between 2.3 and 3.1 for ASTM range set for fine aggregates.

Table 1: Sieve Analysis Result for Fine Aggregate (Sand)

Sieve sizes (mm)	*Mass Retained (g)*	*% Retained (weight)*	*Cumulative % retained*	*Cumulative % Passing (weight)*
4.75	*5.8*	*1.16*	*1.16*	*98.94*
2.36	*19.4*	*3.88*	*5.08*	*94.96*
1.18	*72.7*	*14.54*	*19.59*	*80.42*
0.600	*126.2*	*25.24*	*44.82*	*55.18*
0.300	*84.3*	*16.86*	*61.68*	*38.32*
0.150	*167*	*33.40*	*95.08*	*4.92*
0.075	*18.2*	*3.64*	*98.72*	*1.28*
Pan	*6.4*	*1.28*	*100*	*0.0*
∑	*500*			

Table 2: Sieve Analysis for 3000g of coarse aggregate

Sieve Sizes (mm)	*Mass Retained (g)*	*% Retained*	*Cumulative % retained*	*Cumulative % Passing*
80.00	*0.00*	*0.00*	*0.00*	*100.00*
40.00	*150.00*	*5.00*	*5.00*	*95.00*
20.00	*1100.00*	*36.67*	*41.67*	*58.33*
10.00	*910.00*	*30.33*	*72.00*	*28.00*
4.75	*840.00*	*28.00*	*100.00*	*0.00*
2.36	*0.00*	*0.00*	*100.00*	*0.00*
1.18	*0.00*	*0.00*	*100.00*	*0.00*
0.600	*0.00*	*0.00*	*100.00*	*0.00*
0.300	*0.00*	*0.00*	*100.00*	*0.00*
0.150	*0.00*	*0.00*	*100.00*	*0.00*
Pan	*0.00*	*0.00*	*100.00*	*0.00*

According to the result of sieve analysis of the coarse aggregates in table 2, Fineness Modulus (FM) = sum of cumulative percentage retained on the sieves / 100 = (5.00+41.67+72.00+100.00+100.00+100.00+100.00+100.00+100.00)/100 = 718.67/100 = 7.19, which is within the acceptable limit set for FM between 5.5 and 8.0 for coarse aggregate by ASTM.

Workability of Fresh Concretes

The following results shown in Table 3 and figure 1 were obtained from the cone slump test having height 300mm performed within 2minutes of batching and mixing.

Table 3: Cone Slump and Self Compacting Concrete Test Result

% Sawdust ash replaced	*Height of concrete (mm)*	*Slump of concrete (mm)*
0% sawdust Ash	*240*	*60*
5% sawdust Ash	*230*	*70*
10% sawdust Ash	*211*	*89*
15% sawdust Ash	*240*	*60*
20% sawdust Ash	*245*	*55*
25% sawdust Ash	*253*	*47*

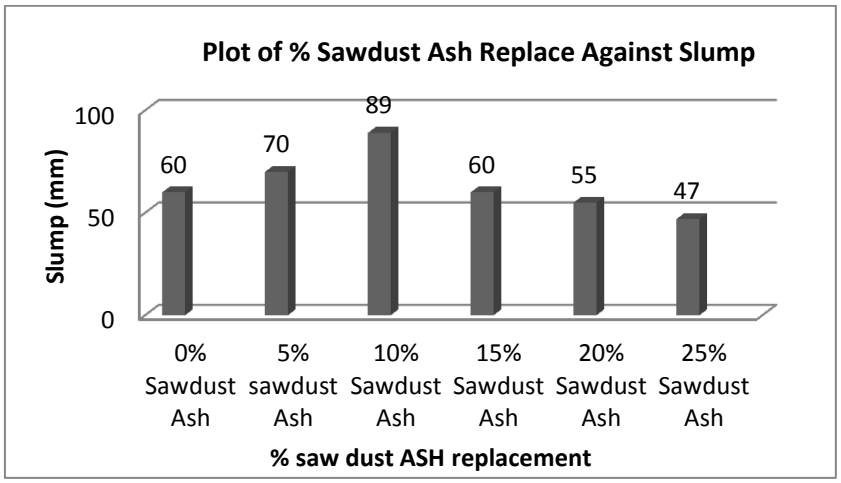


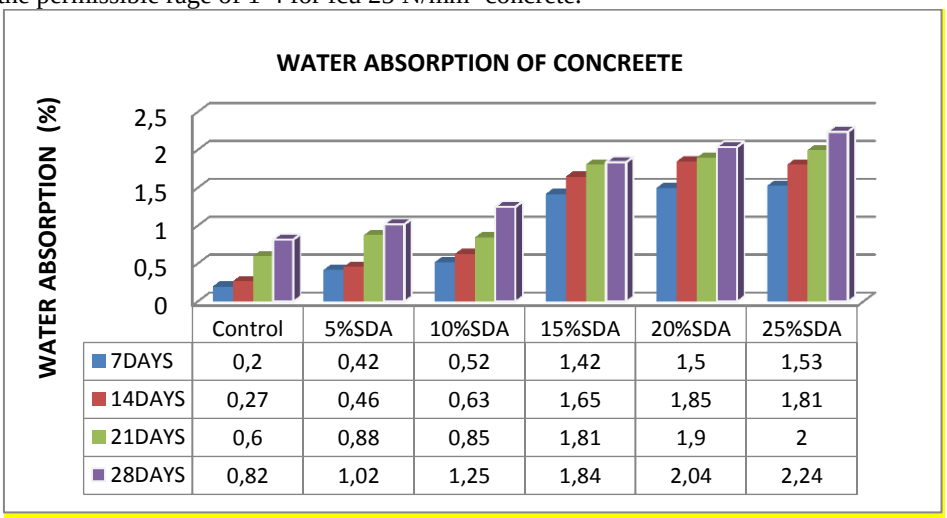
Figure 1. Results for Slump Test

Hardened Concrete Tests

The types of hardened concrete tests done were water absorption and destructive compressive strength tests.

Water Absorption of Concrete

The total increase of water absorption percentage from 0.82 to 2.24 with 0% to 25%SDA replacement respectively at 28 days of curing indicates high rate of sawdust ash water absorption. Fig. 2 showed maximum water absorption of 2.24 which is within the permissible rage of 1-4 for fcu 25 N/mm^2 concrete.



	Control	5%SDA	10%SDA	15%SDA	20%SDA	25%SDA
7DAYS	0,2	0,42	0,52	1,42	1,5	1,53
14DAYS	0,27	0,46	0,63	1,65	1,85	1,81
21DAYS	0,6	0,88	0,85	1,81	1,9	2
28DAYS	0,82	1,02	1,25	1,84	2,04	2,24

Figure 2: Water Absorption of Concretes at 7 to 28 days Curing

Compressive Strength of Concrete

Table 4: Compressive Strength of Concrete Cubes

Day of Curing	*0% sawdust ash (N/mm^2)*	*5% sawdust ash (N/mm^2)*	*10% sawdust ash (N/mm^2)*	*15% sawdust ash (N/mm^2)*	*20% sawdust ash (N/mm^2)*	*25% sawdust ash (N/mm^2)*
7 DAYS	*20.89*	*20.78*	*18.67*	*16.00*	*13.44*	*11.88*
14 DAYS	*25.56*	*24.89*	*20.00*	*16.22*	*13.78*	*13.00*
21 DAYS	*26.67*	*26.22*	*20.56*	*19.11*	*17.56*	*16.67*
28 DAYS	*27.67*	*27.22*	*21.22*	*20.00*	*18.89*	*18.33*

The compressive strength of the sample using 0% replacement (control) at 7days was calculated thus; Fcu = $\frac{470\times1000(N)}{150\times150(mm^2)}$ = 20.89 N/mm^2.

Also, other compressive strengths were calculated in similar manner and recorded. As shown in table 4 and figure 3, the compressive strengths have a progressive strength' growth from 7day - 28day. At 7th day, the control had the highest value followed by the 5% concrete and down from 10% replacement to 25%. At 28 days curing, the control and 5% replacement level had exceeded the target mix design of 25 N/mm^2 thus notifying that the mix at 0.5 water-cement ratio was adequate. Also at this 28days, the remaining concrete from 10%, 15%, 20% and 25% respectively meet up with the stipulated strength for light weight structural concrete with strength of 17 to 63 MPa according to [20].

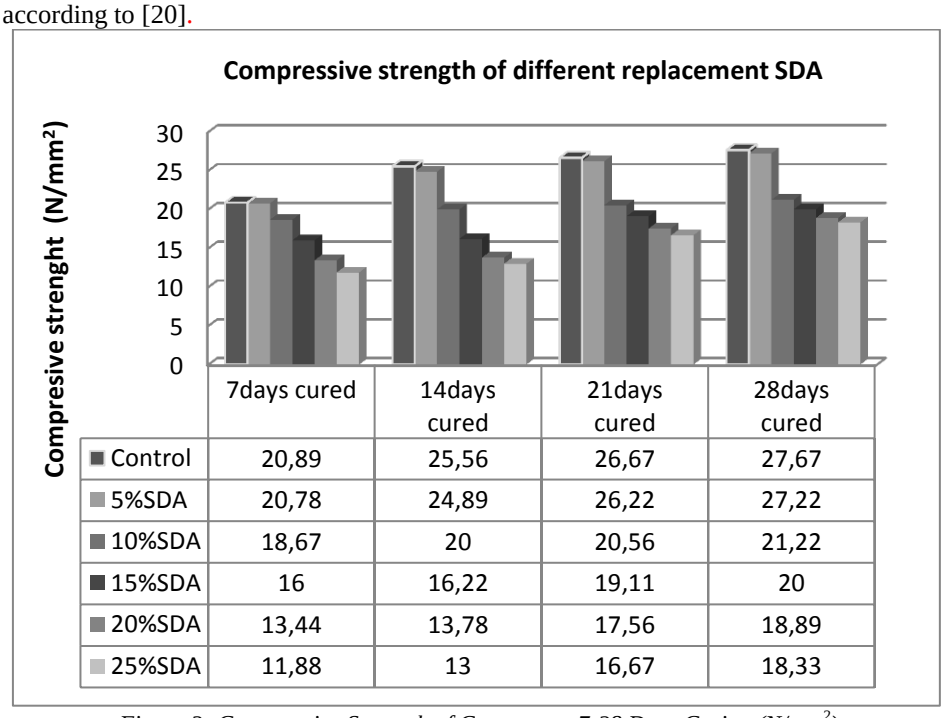


Figure 3: Compressive Strength of Concrete at 7-28 Days Curing (N/mm^2)

CONCLUSION

The project on the application of industrial waste (sawdust) in concrete production yielded good results. It has proven to be a good pozzolan, hence it can be used to improve the properties of concrete in terms of workability and durability. It was discovered that it is applicable in the production of light weight concrete structures at 10% and above in partial replacement of cement with sawdust ash. The use of Sawdust has economic benefit, environmental benefit and technical benefits. It is seen as waste to wealth initiation in agriculture and concrete industry.

The use of *Gmelina arborea* Roxb.,sawdust ash as partial replacement with 10% to 25% of OPC in concrete can be useful in farm structures for Foundation walls; basement walls; structural concrete; walls; reinforced floor slabs; floors for dairy and beef cattle, pigs and poultry; floors in grain and potato stores, hay barns, and machinery stores; septic tanks and water storage tanks; slabs for farmyard manure; roads, driveways, paving and walks; stairways.

Also, 5% partial replacement of cement with *Gmelina arborea* Roxb.,sawdust ash can yield a target strength of concrete grade C25, and applicable for All concrete in milking parlours, dairies,silage silos, and feed and drinking troughs; floors subject to severe wear and weather conditions, or weak acid and alkali solutions; roads and paving in frequent use by heavy machinery and lorries; small bridges; retaining walls and dams; suspended floors, beams and lintels; floors used by heavy,small-wheeled equipment, such as lift trucks; fencing posts and precast concrete components.

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STUDIJA UPOTREBE PEPELA PILJEVINE DRVETA *Gmelina arborea* Roxb. KAO DODATAKA U PROIZVODNJI BETONA U DRŽAVI ABIA, NIGERIJA

Oluwaseun Babalola[1*], Michael Etteben[2], Nkiru Ezejiofor[3], Nnaemeka Nneji[4], David Eze[5], Francis Orji[6], Augustine Igbozulike[7]

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Sažetak. *Gmelina arborea* Roxb.*,* je stablo kišne prašume koje se nalazi u tropskom regionu Nigerije. Studija istražuje izvodljivost i uticaj na osobine betona korišćenjem pepela od piljevine stabla *Gmelina arborea* Roxb., u državi Abia, Nigerija.
Korišćena je betonska mešavina 1:2:4 zapreminskog odnosa i konstantni odnos vode prema cementu od 0,6.

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Testovi su od 60, 70, 89, 60, 55 i 47 mm uz delimičnu nadoknadu od 0, 5, 10, 15, 20 i 25% dodatka (sadržaj pepela). Vrednosti uzoraka na pritisak posle 28-og dana od očvršćivanja za dodatke od 0, 5, 10, 15, 20 i 25% bila je 27.67, 27.22, 21.22, 20.00, 18.89 i 18.33 N/mm^2 retrospektivno.

Istraživanje % zamene (dodatka) pokazuje da sve ispitivane vrednosti zamene imaju dobre osobine i mogu se kategorisati kao dobro poboljšanje mešavine, pri čemu 10% delimična zamena (dodatak pepela) daje najbolje osobine betona.

Pored toga, čvrstoća betona na pritisak dobijena posle 28. dana pokazuje da beton razvija dobru čvrstoću, koja se može povećavati u narednim godinama, jer pozolanski beton razvija kasnije bolju pritisnu čvrstoću (tvrdoću) i izdržljivost od običnog (standardni) betona.

Ključne reči: Stablo *Gmelina arborea* Roxb., pepeo od piljevine, puzolan, beton, obradivost, pritisna čvrstoća

Prijavljen: *Submitted*:	28.10.2019.
Ispravljen: *Revised*:	06.02.2020.
Prihvaćen: *Accepted*:	09.03.2020.

Univerzitet u Beogradu
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Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 56 – 66

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 56 – 66

UDK: 711.14:551.511:532.57:556.53

Original scientific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002056G

PRIMENA GIS ALATA ZA PRIPREMU ULAZNIH PODATAKA ZA *HBV-light* HIDROLOŠKI MODEL

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Sažetak: Uloga hidroloških modela u vodoprivredi je značajna. Jedna od njihovih važnih primena je u razvoju i upravljanju vodnim resursima, uključujući i kvalitet vode i pronos nanosa. Semi-distribuirani hidrološki modeli, kao što je *HBV-light*, pružaju mogućnost podele sliva reka na podslivove i na zone prema visinama i prema vrsti zemljišnog prekrivača. Da bi se pripremili ulazni podaci za ove modele GIS alati pružaju značajnu podršku. U radu je prikazana metodologija pripreme ulaznih podataka, korišćenjem alata *QGIS*, za *HBV-light* hidrološki model, koji služi za kontinualne hidrološke simulacije. Ovaj model transformiše padavine sa sliva u oticaj. U okviru metodologije, na primeru sliva reke Veternice, opisane su i upoređene tri alternativne metode.

Ključne reči: *GIS, hidrološki model, HBV-light*

UVOD

Hidrološki modeli uzimaju sve veću ulogu u vodoprivredi. Koriste se za planiranje količine vodnih resursa, procenu merodavnih proticaja, u simuliranju poplavnih talasa, za potrebe analiza rada vodoprivrednih sistema, pri analizi uticaja klimatskih promena na vodne resurse. Mogu biti od pomoći u planiranju, upravljanju i razvoju u vodoprivredi [10].

Hidrološki modeli „padavine-oticaj“ simuliraju proces transformacije padavina u oticaj na slivu. Stepen uprošćavanja ovog procesa u modelu zavisi od raspoloživosti ulaznih podataka i od informacije koje model treba da pruži. Načelno, ulazni podaci u hidrološki model su hidrometeorološki podaci, fizičko-geografske karakteristike sliva i podaci o parametrima procesa, početni, granični i konturni uslovi.

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Rad je realizovan uz finansijsku pomoć Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, u okviru projekta iz programa tehnološkog razvoja „Savremeni biotehnološki pristup rešavanja problema suše u poljoprivredi Srbije“, TR31005 i „Ocena uticaja klimatskih promena na vodne resurse Srbije“, TR37005.

Kod prostorno homogenih modela ceo sliv je predstavljen jednim skupom parametara, dok semi-distribuirani modeli pružaju mogućnost podele sliva na podslivove.

Semi-distribuiran model sliva predstavljen je skupom modela sa homogenim parametrima. Kod distribuiranih modela parametri variraju u prostoru i imaju mogućnost različitosti u svakom elementu računske mreže. Oni mogu donekle da uzmu u obzir prostornu varijabilnost u procesima, ulazima, graničnim uslovima i slivnim karakteristikama [14]. Das at al. [6] su pokazali da semi distribuirani hidrološki modeli daju bolje rezultate simulacije od distribuiranih, što pripisuju nedovoljnoj tačnosti ulaznih podataka u elemente mreže.

Upotreba podataka o strukturi elevacije jedan je od najvažnijih aspekata za postizanje prostorne varijabilnosti. Osnovni model koji pruža podatke o nadmorskoj visini je *Digital elevation model* – (DEM) [9]. Međutim, upotreba DEM-a u modeliranju slivova zahteva efikasne alate za upravljanje i obradu velikih baza podataka. Primena GIS tehnologija tu može pomoći kako u pripremi ulaznih podataka i parametara modela, tako i u kvalitetnom prikazu rezultata simulacija [5].

U radu je prikazana metodologija pripreme ulaznih podataka za semi-distribuirani *HBV-light* hidrološki model [13], na primeru sliva Veternice, korišćenjem alata *QGIS* 3.6.0.

MATERIJAL I METODE RADA

Sliv reke Veternice prostire se na južnom delu Srbije. Ona je leva pritoka Južne Morave. Duga je 75 km, dok je površina sliva reke 515 km^2. Veternica ima veoma kolebljiv vodostaj, sa proleća nabuja, a leti skoro presuši [3]. Hidrološka stanica površinskih voda Leskovac beleži oticaj sa 500 km^2 sliva [11]. Na osnovu podataka iz perioda 1948-2012 njen proticaj varira između 0 i 216 m^3s^{-1} sa dugogodišnjom srednjom vrednošću od 3,98 m^3s^{-1}. Specifični oticaj sa sliva je 7,96 $Ls^{-1}km^{-2}$ [2] Visinske kote u slivu su u rasponu od 211 do 1440 mn.m.

Za simulaciju proticaja Veternice korišćen je *HBV-light* hidrološki model. To je deterministički, konceptualni model namenjen za kontinualne hidrološke simulacije scenarija oticaja na slivu, uz pomoć vremenskih serija ulaznih podataka. Prostorno posmatrano *HBV-light* je semi-distribuiran model, što znači da sliv može biti podeljen na podslivove, a svaki od njih na različite zone u zavisnosti od nadmorske visine i od vrste zemljišnog prekrivača. Zemljišni prekrivač, u modelu, podrazumeva šume, poljoprivredne, urbane i vodene površine [12]. Ulazni podaci u model se obezbeđuju za svaki podsliv posebno. Predstavljaju vremenski niz sledećih podataka: dnevnih suma padavina (P) (mm dan^{-1}), prosečnih dnevnih temperatura vazduha (T) (^oC), dnevnih suma potencijalne evapotranspiracije (PET) (mm dan^{-1}). Za period kalibracije i validacije, od ulaznih podataka, treba obezbediti dnevne proticaje na izlaznom profilu podsliva (Q) (mm dan^{-1}) za što duži vremenski niz. Takođe, unose se i podaci o površini svakog podsliva (km^2), zatim broj elevacionih zona u zavisnosti od nadmorske visine i srednja visina svake zone (mn.m.), nadmorska visina meteorološke stanice sa koje su korišćeni podaci (mn.m.), broj zona u zavisnosti od vrste zemljišnog prekrivača i njihova zastupljenost, izražena u %, na svakoj elevacionoj zoni.

U ovom radu, sliv Veternice je tretiran kao jedan podsliv, podeljen na 6 elevacionih zona (model ukupno dozvoljava 20), od kojih je svaka zona izdeljena na šume, poljoprivredne, urbane i vodene površine.

Priprema klimatskih podataka, izračunavanje površine sliva, kao i određivanje zastupljenosti pojedinih vrsta zemljišnog prekrivača na elevacionim zonama, urađena je upotrebom softverskog programa *QGIS* verzije 3.6.0. Quantum GIS (*QGIS*) je javno dostupna računarska GIS aplikacija, otvorenog koda, koja omogućuje upravljanje, uređivanje, analiziranje i vizuelizaciju prostornih podataka. Programski paket se svakodnevno razvija i dograđuje. Pored brojnih ugrađenih funkcija, postoji veliki broj dodataka (*Plugins*) kojima je moguće obaviti i specifične zahvate nad geopodacima. *QGIS* koristi standardne formate podataka, tako da je moguće iste podatke koristiti i unutar drugih programskih paketa.

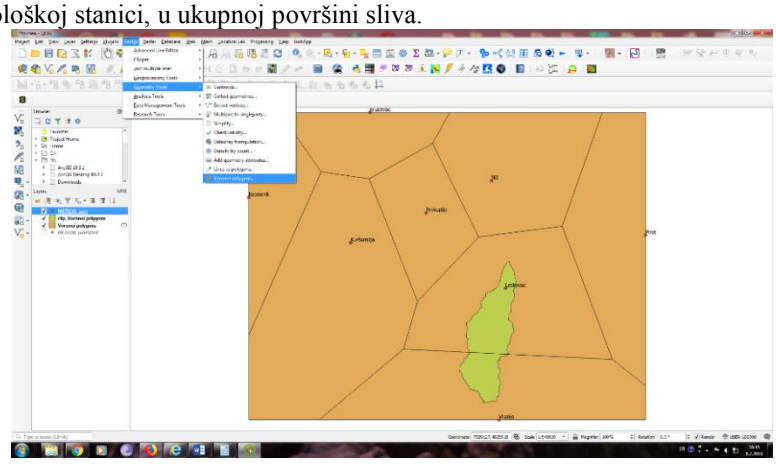
Kao podloga za određivanje elevacionih zona korišćena je baza podataka *Shuttle radar topographic mission* (*SRTM* 90m *Digital Elevation Data*), rezolucije 90m x 90m preuzet sa sajta *CGIAR-CSI*, (*Consortium for Spatial Information*) [8].

Za određivanje zona prekrivenosti površine, korišćena je baza podataka sa sajta *Copernicus Land Monitoring Service* (*CORINE*) [4].

REZULTATI ISTRAŽIVANJA I DISKUSIJA

Postupak pripremanja meteoroloških podataka za ulaz u model

Meteorološki podaci, u *HBV-light* modelu, se zadaju kao vremenski nizovi, i to za svaki podsliv po jedan set od tri niza (P, T, PET). S obzirom da je reč o velikoj površini, meteorološki podaci sa jedne stanice ne mogu biti merodavni za ceo sliv. Zbog toga su korišćeni podaci sa šest meteoroloških stanica: Kuršumlija, Prokuplje, Leskovac, Niš, Vranje i Pirot. Od šest setova podataka, ponderisanjem se dobija jedan, merodavan set. Ponderisanje se vrši na osnovu procentualnog učešća pripadajuće površine meteorološkoj stanici, u ukupnoj površini sliva.



Slika 1. Tisenovi poligoni na slivu Veternice, dobijeni primenom programa *QGIS*

Figure 1. Thiessen polygons in the River Veternica catchment, obtained through the application of the QGIS program.

Pomoću Tisenovih (*Thiessen*) poligona se primenom *QGIS* odredi procentualni udeo sliva za koji je svaka stanica merodavna. Postupak je: na osnovu položaja meteoroloških stanica, koje treba predstaviti kao tačke, pomoću *Vector/Geometry Tools/Voronoi Polygons* dobiju se poligoni koji sadrže po jednu stanicu (Sl. 1). Granice (Tisenovih) poligona čine linije simetrije između stanica. Presecanjem Tisenovih poligona sa slivom, koji je predstavljen poligonom, dobijaju se, po svakoj stanici, pripadajuće površine. U *Attribute Table* formiraju se dve dodatne kolone. U prvoj koloni se preko *Field Calculator/Geometry/$area* izračuna površina svakog poligona, dok u drugoj, takođe primenom *Field Calkulator*, se deljenjem vrednosti iz prve kolone sa ukupnom površinom sliva i množenjem sa 100, izračuna procentualni udeo površine svakog poligona u ukupnoj površini sliva. Ovi podaci, dobijeni u *QGIS*–u omogućavaju ponderisanje meteoroloških podataka (nizova) kao i ponderisanje visinskih kota na kojima su ovi podaci mereni. Ovaj proračun se radi, najčešće u programu *Microsoft Excel*. S obzirom na promenljivost meteoroloških veličina sa elevacijom, sam *HBV-light* model koriguje podatke za svaku visinsku zonu u podslivu.

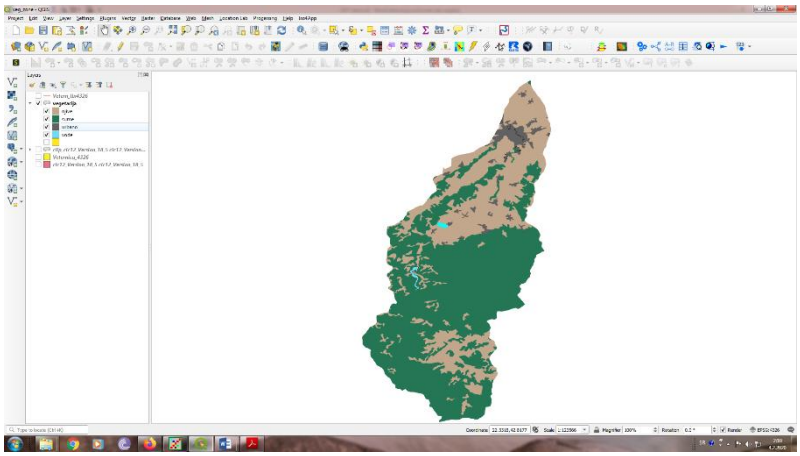
Postupak određivanja vrste zemljišnog prekrivača na elevacionim zonama

Postupak pripreme do sada opisanih ulaznih podataka je manje-više standardan. Za određivanje procentualnog učešća pojedinih zemljišnih prekrivača na elevacionim zonama, ne postoji standarni postupak. S jedne strane potrebna je baza podataka o rasporedu pojedinih vrsta zemljišnih prekrivača na proučavanom području, a sa druge strane potrebna je baza podataka o visinskim kotama terena. Iz podataka o elevaciji terena treba doći do zahtevanih elevacionih zona. Nakon izdvajanja elevacionih zona, upitima nad bazama treba izvući veličine površina gde se elevacione zone i zone pod pojedinim vrstama zemljišnih prekrivača ukrštaju. Sopstvenim iskustvom, razradili smo tri različita metodološka postupka, koji su prikazani i upoređeni u nastavku.

Postupak izdvajanja zona pod pojedinim zemljišnim prekrivačima

Sa sajta Copernicus Land Monitoring Service [4] preuzeta je baza podataka o načinu prekrivenosti površine, clc12Version_18_5. Ona je uvučena u *QGIS*, gde se kao poligoni (na osnovu atributa u koloni *LABEL1*), različitim bojama prikazuju različite vrste zemljišnog prekrivača. Presecanjem poligona: zemljišnih prekrivača i sliva (*Clip*), dobijeni su poligoni šuma, poljoprivrednih, urbanih i vodenih površina (Sl. 2).

Da bi se moglo izvršiti ukrštanje poligona zemljišnih prekrivača sa poligonima elevacionih zona, potrebno je zone zemljišnih prekrivača razdvojiti u posebne datoteke: šume, poljoprivredne, urbane i vodene površine. Iz baze podataka selekcijom zapisa u tabeli (*Select By Expression*), izdvojeni su poligoni sa istim zemljišnim prekrivačem i naredbom *Export/Save Selected Features As...* zapamćeni su u zasebne *shp* datoteke.



Slika. 2. Poligoni zemljišnog prekrivača sliva reke Veternice. Zelena boja označava šume, braon poljoprivrednu površinu, plava vodene površine i svetlo siva urbanu sredinu

Figure 2. Polygons of surface coverings of the River Veternica catchment. Green colour indicates forests, brown agricultural area, blue aquatic areas and light gray urban environment.

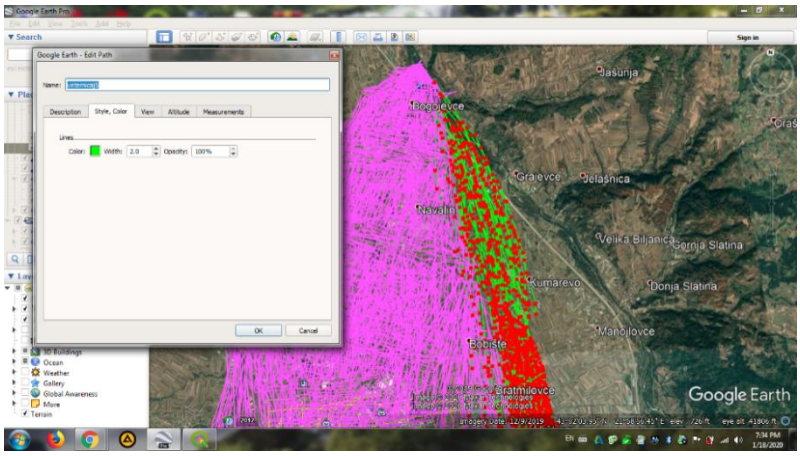
Postupak izdvajanja elevacionih zona

Pošto se padavine i temperatura menjaju u zavisnosti od visinske kote terena, što hidrološki model uzima u obzir, potrebno je sliv podeliti na elevacione zone. Na slivu Veternice najniža kota je 214 mn.m. a najviša 1440 mn.m. U ovom radu sliv Veternice podeljen je na 6 zona: ispod 400, 400-600, 600-800, 800-1000, 1000-1200 i iznad 1200 mn.m. Elevacione zone treba da su predstavljene poligonima da bi se mogle „ukrštati“ sa zonama zemljišnih prekrivača, koje su date kao poligoni.

Za dobijanje elevacionih zona razmatrane su tri metode.

Prema prvoj metodi, u proučavanoj zoni nasumično su se skidale koordinate 150000 tačaka (geolokacija) preko *Google Earth Pro*-a (Sl. 3). Ovaj set koordinata se pamtio u fajlu sa ekstenzijom *kml (Keyhole Markup Language)*, koji se posle učitao u *TCX Converter*. Uloga ovog programa je bila da pridruži odgovarajuće nadmorske visine (altitude) svakoj tački i da se preko njega set zapamti u oblik tekstualne datoteke sa *csv* (*Comma Separated Value*) ekstenzijom – gde su pojedini podaci razdvojeni zarezima. Ova tekstualna datoteka se učitala u *QGIS* formirajući sloj tačaka. Kako bi se ovaj sloj sačuvao za dalje korišćenje, snimljen je (*Save as*) u odgovarajuću *shp* datoteku. Ako se bira postupak da se pomoću ovih tačaka formira mreža nepravilnih trouglova (*TIN*), tj. model terena, koji se može upotrebiti za kreiranje izolinija, onda se u nastavku od po dve susedne izohipse (izolinije) prave poligoni, tj. elevacione zone. Pretvaranje linija u poligone je osetljiv korak jer linije ne smeju imati prekid i moraju se dodirivati (odnosno biti bliže od zadate tolerancije). Zbog toga je izabran drugi način. Alatom *Vector/Contour/filed contours* dobiju se poligoni oivičeni izohipsama. Što znači, odmah se dobiju elevacione zone, što se u našem slučaju i traži. Ova metoda za male slivove daje dobar rezultat, što se vidi na slici 6, gde su dobijene izohipse po prvoj i drugoj metodi upoređeni međusobno a takođe i sa izohipsama na topografskoj karti.

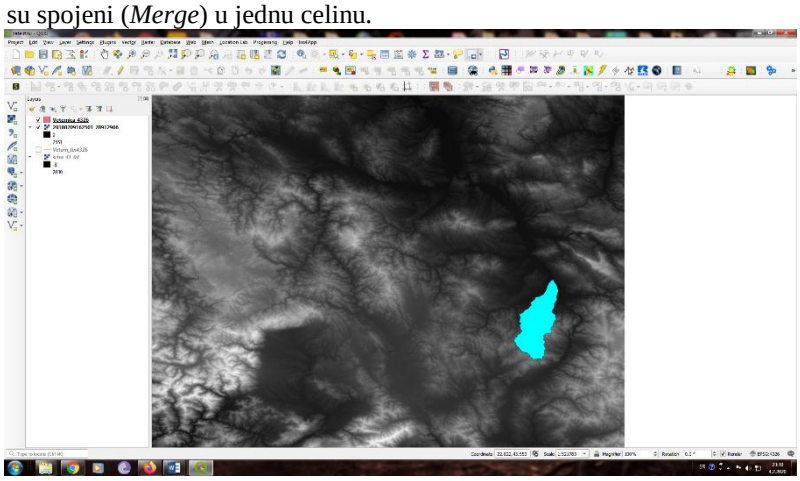
Međutim, Gregorić [7] za veliki sliv (Zapadna Morava - oko 16000 km^2) nije dobila zadovoljavajuću tačnost. Preciznost ove metodologije zavisi od gustine mreže uzetih tačaka kao podloge. Predlog za poboljšanje tačnosti kod većih slivova je da se proba umesto nasumičnim uzimanjem tačaka, ciljano uzimanje tačaka na grebenima i tokovima, što bi pored povećanja tačnosti smanjilo i neophodan broj tačaka [1].



Slika. 3. Skidanje koordinata geolokacija u *Google Earth Pro* programu

Figure 3. Download coordinates of geolocations in Google Earth Pro.

U drugoj metodologiji, za podlogu, kao DEM, su korišćeni satelitski snimci [8] (Sl. 4). Oni su spojeni (*Merge*) u jednu celinu.

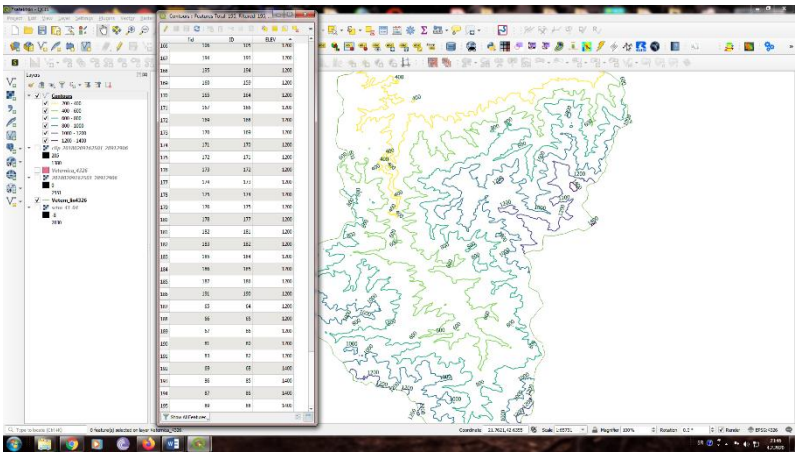


Slika. 4. Primeri satelitskih snimaka koji su korišćeni kao DEM [8].

Figure 4. Examples of satellite images used as Digital Elevation Model (DEM) [8]

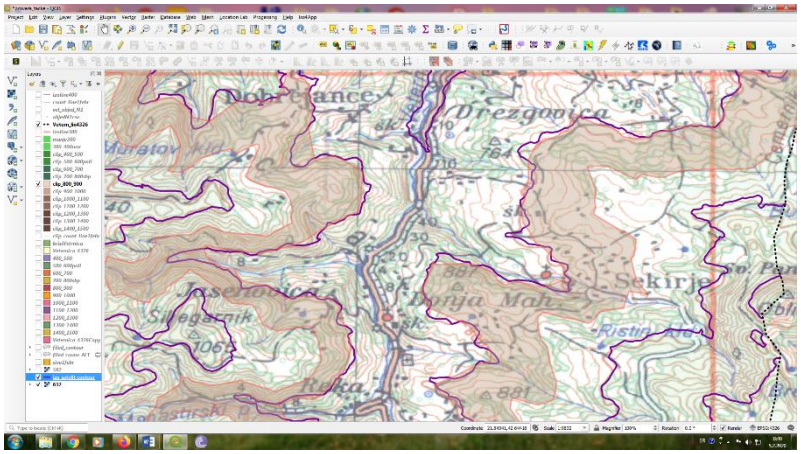
Nakon toga satelitski snimak je isečen (*Clip*) pomoću poligona sliva i sa njega su skidane izohipse (*Raster/Extraction/Contour*) sa određenom (u našem primeru 200m) ekvidistancom.

Sloj (*layer*) sa izohipsama je spojen (*Vector/Data Management/Merge vector layer*) sa slojem koji sadrži vododelnicu sliva, u cilju da bi izohipse zajedno sa vododelnicom činile zatvorene linije. Od tih linija, nadalje, su formirani poligoni (površine između dve susedne izohipse) (*Vector/Geometry Tools/Lines To Polygons*) koji predstavljaju elevacione zone. Ovaj postupak u praksi ima i dodatne korake. Program sa satelitskog snimka skida linije koje često i nisu izohipse. Osim toga, neke linije su otvorene linije. Pre spajanja u poligone morala se vršiti provera i korekcija (brisanje i spajanje). Kod Veternice, koja ima relativno mali sliv (oko 500km^2), sa ekvidistancom 200m, program je prepoznao 195 linija (Sl. 5) kao izohipse, čiji broj je proverom sveden na 40.



Slika. 5. Izohipse dobijene alatom *Contour* sa satelitskog snimka

Figure 5. Isohypses obtained from the Contour tool from a satellite image

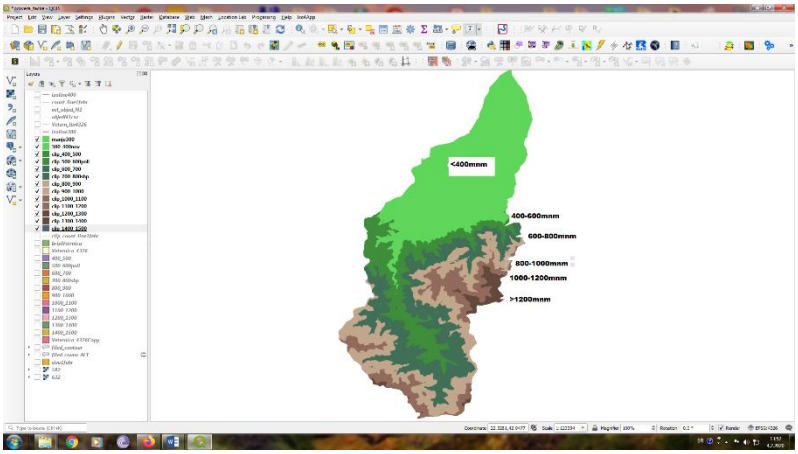


Slika. 6. Upoređenje slaganja rezultata prve metode (svetlo braon poligoni) i druge metode (ljubičaste linije) sa izohipsama na topografskoj karti

Figure 6. Comparison of the matching results of the first method (light brown polygons) and the second method (purple lines) with isohypses on the topographic map.

U slučaju malog sliva ovaj korak nije predstavljao problem. Međutim, za sliv Zapadne Morave, kako navodi Gregorić [7], trebalo je proveriti i korigovati 21741 liniju, za površinu sliva od oko 16000km^2, pri ekvidistanci 100m, što je bio vremenski veoma zahtevan posao.

Sa ciljem da se izbegne vreme potrebno za skidanje koordinata geolokacija, za treću ispitanu metodu korišćen je satelitski snimak, kao i u drugoj metodi. U traganju za idejom da se izbegne mukotrpna provera i korekcija izohipsi došlo se do ideje da se nakon isecanja satelitskog snimka u obliku sliva, vrednosti za nadmorske visine regrupišu (*Processing Toolbox/Raster analysis/Reclassify by table*). Ovako se vrednosti zamenjuju, npr. u svim okcima gde su stajali brojevi od 600 do 800 zamene se sa brojem 700 (srednjom vrednošću intervala). Često je pre ovog koraka potrebno na satelitskom snimku popuniti „nodata“ (*Raster/Analysis/Fill* nodata) okca. Sada se na osnovu novih vrednosti naprave vektori (*Raster/Conversion/Polygonize (raster to vector)*), odnosno poligoni koji nose kao atribut nove, zadate vrednosti elevacije (Sl. 7). Ovom metodom se dobijaju i neki veoma mali, nerealni poligoni, kao što su kod druge metode dobijene kvazi izohipse, međutim, ovi poligoni ne moraju manuelno da se koriguju, s obzirom da je površina sitnih poligona u odnosu na površinu sliva zanemarljiva. U nastavku, selektuju se poligoni prema atributu (*Expression*) nadmorska visina, koja treba da bude ista za sve izabrane. Izabrani poligoni se zapamte u zasebnu datoteku. Napravi se toliko datoteka koliko ima elevacionih zona.

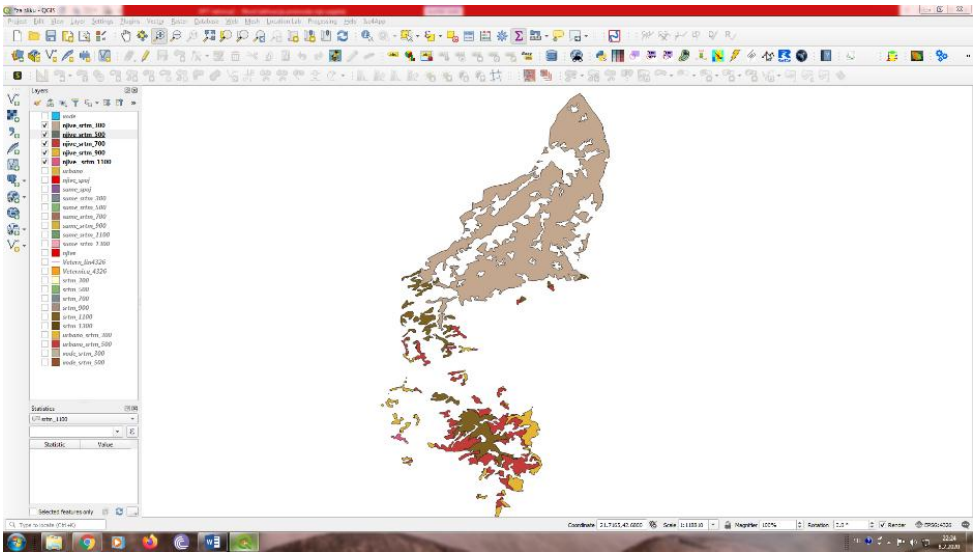


Slika. 7. Elevacione zone na slivu Veternice dobijene na bazi satelitskog snimka reklasifikacijom

Figure 7. Elevation zones in the catchment of the River Veternica obtained from a satellite image by reclassification

Ukrštanje poligona zemljišnih prekrivača i elevacionih zona

HBV-light model zahteva određivanje procentualnog učešća površine zemljišnih prekrivača na elevacionim zonama. Da bi se došlo do tih podataka, potrebno je napraviti presecanje (*Plugins/Clip Multiple Layers/Clip all displayed layers*) slojeva svih uključenih elevacionih zona, sa slojem svakog zemljišnog prekrivača, posebno (Sl. 8)



Slika. 8. Poljoprivredne površine na slivu reke Veternice, prikazane različitim bojama u zavisnosti od nadmorske visine

Figure 8. Agricultural areas in the river Veternica catchment, shown in different colours depending on altitude

Rezultati kompletno urađenog postupka, na primeru sliva Veternice, dati su u tabeli 1, u kolonama elevacione zone. Vrednosti su izražene u procentima u odnosu na veličinu površine celog sliva, kao što je zahtevano u *HBV-light* modelu. Šume prekrivaju 60% zemljišta na slivu Veternice, najviše na elevacionoj zoni od 600-1000mn.m. Veliki deo poljoprivrednih površina (25%) na kotama je manjim od 400 mn.m.

Tabela 1. Zastupljenost pojedinih vrsta zemljišnih prekrivača na svakoj od elevacionih zona na slivu reke Veternice (%)

Table 1. The coverage of certain types of surface coverings in each of the elevation zones in the catchment of the River Veternica (%)

	Elevacione zone (mn.m.) Elevation zones (msl)						*Ukupno Total (%)*
	<400	*400-600*	*600-800*	*800-1000*	*1000-1200*	*>1200*	
Vodene povr. Aquatic areas	0,2	*0,0*	-	-	-	-	*0,2*
Urbano pod. Urban environments	3,7	*0,0*	-	-	-	-	*3,7*
Poljop. povr. Agricultural areas	25,1	*4,1*	*4,4*	*2,3*	*0,1*	-	*36,0*
Šume Forests	8,7	*9,0*	*15,5*	*15,6*	*8,9*	*2,4*	*60,1*
Ukupno Total (%)	37,7	*13,1*	*19,9*	*17,9*	*9,1*	*2,4*	*100,0*

ZAKLJUČAK

Hidrološki modeli zahtevaju ulazne podatke koji su vezani za prostor. *QGIS* pruža veliku pomoć u pripremi ovih podataka. U ovom radu, na primeru sliva Veternice, prikazana je primena *QGIS* u pripremi podataka za hidrološki model *HBV-light*. Prikazano je: priprema klimatskih podataka kao i određivanje zastupljenosti pojedinih zemljišnih prekrivača na elevacionim zonama.

Primenom alata za određivanje Tisenovih poligona veoma je uspešno i lako izvršeno ponderisanje vrednosti nizova ulaznih meteoroloških podataka i visinskih kota na kojima su mereni.

Postupak dobijanja procentualnog učešća pojedinih zemljišnih prekrivača na elevacionim zonama, razdvojen je na nekoliko koraka. Prvi korak predstavlja izdvajanje površina pod određenim zemljišnim prekrivačima iz baze podataka, drugim korakom se vrši određivanje elevacionih zona i u trećem se vrši njihovo ukrštanje.

Zone različitih zemljišnih prekrivača terena u slivu su izdvojene korišćenjem baze podataka clc12Version_18_5 [2].

Za određivanje elevacionih zona osmišljena su i ispitana tri načina. Za manji sliv (kao što je Veternica), sa svakom od ispitanih metoda se došlo do traženog rezultata. Prvi i drugi su vremnski zahtevni i što je sliv veći i potrebno vreme za sprovođenje postupka raste. Sa ciljem da se izbegne vreme potrebno za skidanje koordinata geolokacija sa *Google Earth Pro* (prva metoda), za treću ispitanu metodologiju korišćeni su satelitski snimci.

U traganju za idejom, da se izbegne mukotrpna provera i korekcija izohipsi, došlo se do metode gde se na satelitskom snimku terena vrši reklasifikacija podataka o elevaciji u mreži. Ovaj metod za ispitivanu svrhu dao je najbolje i zadovoljavajuće rezultate.

Uloga *QGIS*–a u pripremanju ulaznih podataka za hidrološke modele je veoma značajna, ali nedovoljna bez kvalitetnih podloga, kao što su digitalni modeli za visinsko predstavljanje terena i razne baze podataka.

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APPLICATION OF GIS TOOLS FOR PREPARATION OF INPUT DATA FOR HBV-light HYDROLOGICAL MODEL

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Abstract: The role of hydrological models in water management is significant. One of their important applications is the development and management of water resources, including water quality and sediment transport. Semi-distributed hydrological models, such as HBV-light, provide the possibility of dividing the catchment into sub-catchments and zones according to height and type of land cover. GIS tools provide significant support to prepare input for these models. The paper presents the methodology for preparing input data, using the QGIS tool, for the HBV-light hydrological model, which is used for continuous hydrological simulations. This model transforms precipitation from the catchment into runoff. Three alternative methods are described and compared within the methodology, based on the example of the Veternica river catchment.

Key words: *GIS, Hydrological model, HBV-light*

Prijavljen: *Submitted:*	12.02.2020.
Ispravljen: *Revised:*	10.03.2020.
Prihvaćen: *Accepted:*	30.03.2020.

Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XLV
Broj 2, 2020.
Strane: 67 – 78

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XLV
No. 2, 2020.
pp: 67 – 78

UDK: 551.501:621.31:631.3

Original scietific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002067A

IRRIGATION SYSTEM BASED ON ARDUINO UNO MICROCONTROLLER

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Abstract: In crop production, a healthy water balance is essential for high quality yields. Under-watered crops suffer from nutrient deficiencies while over-watered plants are more susceptible to diseases pressure and can in some cases lead to root death through suffocation. Also over-watered plants are not able to withstand dry spells during dry season. The aim of this paper is to use control engineering principles and concepts to provide a microcontroller based irrigation system. The system helps in saving money and water and at the same time increasing crops production. The automated irrigation system is controlled using ATmega328 microcontroller based on Arduino platform. The system is programmed via the microcontroller to give interrupt signal to the irrigation system (drip, sprinkler, ditch etc.) depending on the soil moisture levels. The soil moisture/humidity levels are checked using soil moisture sensor. Whenever there is a change in moisture/humidity in the soil, this sensor senses the change and gives an interrupt signal to the micro-controller and thus the watering system is activated or deactivated.

Keywords: *Irrigation system, microcontroller*

INTRODUCTION

1.1 Brief Background

The continuous increase in food demand requires a rapid improvement in food production technologies.

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Food insecurity is a major challenge in developing countries. In those countries where the economy is mainly agriculture based, use of technology to improve on yields is paramount.

Agriculture in some countries is mainly rain fed. Global warming has led to climate changing thus rendering the rain fed agricultural systems unreliable. This has resulted on more land being put under irrigation to meet the food demand for the growing population.

In Kenya for example, approximately 125,000 hectares of land is under irrigation out of the estimated potential of 1.3 million hectares. Only 30% of the 1.3 million hectares potential irrigation land has available water resources while the other 70% require water harnessing for irrigation to be realized.

Irrigation is the process of artificial application of water to land to aid crops growth. It is mainly used during dry seasons or in dry areas where rainfall is scarce.

1.2 Types of Irrigation

1.2.1 Ditch Irrigation

This is one of the earliest irrigation methods to be used. Ditches/trenches are dug out and crops are planted along the ditches in rows.

1.2.2 Terrace Irrigation

The land is shaped into steps. Crops are planted on the flat areas. Water flows down the steps watering each of the flat areas. This method is both time and labor intensive in building the terraces.

1.2.3 Drip Irrigation

This is one of the most effective and efficient method of irrigation as water is dripped at the crop root zone. The method saves water from runoff and evaporation.

1.2.4 Sprinkler Irrigation

This method uses overhead sprinklers. Each sprinkler irrigates a given area. During installation care should be taken to avoid over or under watering some areas. If poorly installed a lot of water is wasted via runoff.

1.2.5 Rotary Systems

This is an improvement of sprinkler irrigation method where sprinklers are mechanically moving in a rotary/circular manner. This method is best suited for huge tracks of land. This method is more efficient than the basic sprinkler method.

This paper presents a microcontroller based irrigation system which monitors and controls the soil moisture content so as to optimize the application of water. Good water balance leads to maximum crop production.

The system presented automates irrigation systems with the use of low cost sensor, microcontroller and the simple circuitry, thereby making it a low cost. Some works related to the topic of this paper can be found in literatures[1-5].

2- Design and Implementation

The system has three major units; humidity sensing unit, control unit and the output unit. The soil humidity is detected using YL-69 soil sensor (a resistance type sensor). The control unit is achieved using ATMega328 microcontroller based on Arduino platform. The output of the control unit is used to control the irrigation system by switching it on and off depending on the soil moisture contents. Two stages of design are undertaken; hardware and software.

2.1 Hardware Design

2.1.1 Control Unit: ATMega328 microcontroller on Arduino platform

ATMega328 microcontroller on Arduino platform is selected the control unit of the microcontroller. Arduino Uno shown in Fig.1 is selected from the expansive Arduino family. Arduino Uno has a total of 20 inputs pins of which 14 are digital and 6 are analog inputs. The digital pins can be used as either inputs or outputs and also 6 of the 14 pins can be utilized as pulse width modulation (PWM). The board has a 16 MHz ceramic resonator, a universal serial bus (USB) connection and a power jack.

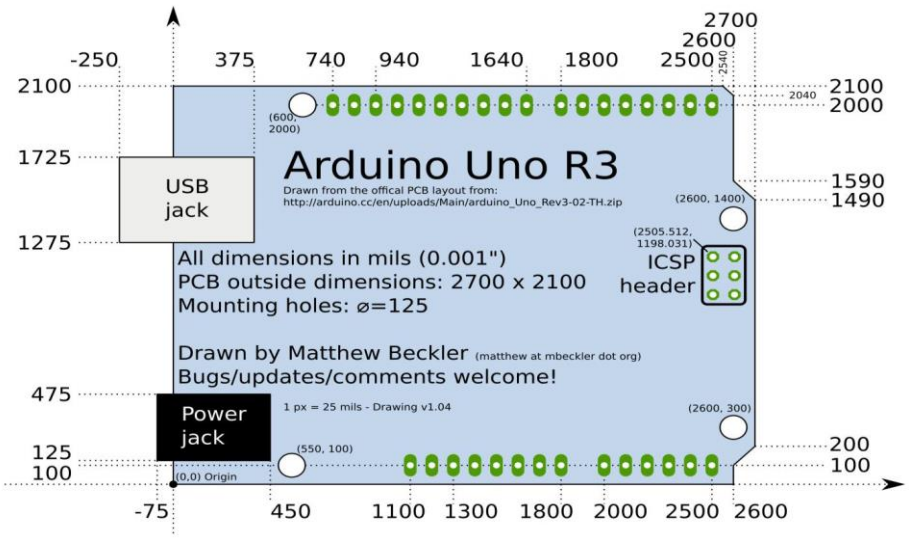

Figure 1. Arduino Uno

In the design of the system, analog pins are selected as the Arduino input and digital pin is selected as the Arduino output pins. Other important pins on the Arduino board are shown in Table 1.

Table 1. Important pins in Arduino

AREF	*Analog Reference pin*
GND (Digital side)	*Digital Ground*
Vin	*Input voltage (external power source)*
5V	*Regulated power to the microcontroller*
3.3V	*3.3V generated by the on-board FTDI chip*
GND	*Ground*

The pins on the Arduino are selected as shown in Table 2.

Table 2. Selected pins on Arduino

Pin	***Connections***
Digital pin 2	*LCD D7 pin*
Digital pin 3	*LCD D6 pin*
Digital pin 4	*LCD D5 pin*
Digital pin 5	*LCD D4 pin*
Digital pin 11	*LCD Enable*
Digital pin 12	*LCD RS pin*
Digital pin 7	*Connection to Water Pump*
Digital pin 8	*LED Pin indicating Soggy soil*
Digital pin 9	*LED Pin indicating Moist soil*
Digital pin 10	*LED Pin indicating Dry soil*
Analog Pin 4	*Connection to Soil Moisture Sensor*
VCC	*5VDC*
GND	*Ground*

2.1.2 Sensing Unit

2.1.2.1 YL-69 soil moisture sensor connection to Arduino

YL-69 soil moisture sensor is interfaced to the Arduino through a digital printed board circuit(PCB) drive. The PCB drive has a digital potentiometer and a LM393 comparator. The LM393 comparator is used to compare the voltages across the sensor probes and the set Vcc voltage. The digipot is used to alter the sensitivity of the sensor when connected in digital mode. The out of the PCB drive has four connections pins as shown in Table 3.

Table 3 YL-69 PCB pins

Vcc	*Connected to 5VDC*
GND	*Connected to ground*
A0	*Analog value output connector*
D0	*Digital value output connector （0 or 1）*

The analogue configuration is selected as its more stable compared to the digital configuration. The PCB drive pin A0 is connected to the Arduino analog pin A0. Fig.2 shows YL-69 connection to Arduino board.

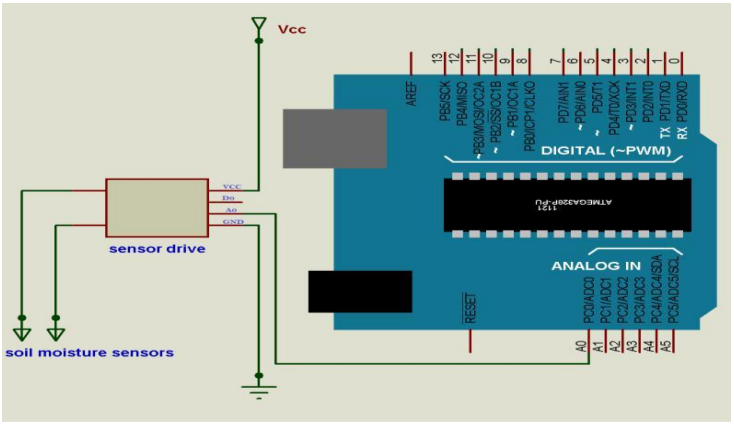

Figure 2. YL-69 Connection to Arduino board

The output of the sensor to the Arduino analog pin A0 is resistance. The resistance to flow of current between the sensor probes changes with soil moisture level and soil type. The current passing through the sensor probes (I_{out}) for different soils and different soil moisture levels is calculated as shown below:

$$I_{out} = Vcc / \{\text{soil resistance value } (R_S)\} \quad \text{..... (1)}$$

2.1.3 Output Unit

2.1.3.1 LCD interface with Arduino

To affect display, a 16x2 Liquid Crystal Display (LCD) is chosen. LCD pins D4, D5, D6 and D7 are used as data lines in a 4-bit mode configuration. These pins are connected to Arduino pins 5, 4, 3 and 2 respectively. Pin 15(A) is connected to Vcc and pin 16 (K) is connected to GND. These pins (A and K) are for the light emitting diodes(LEDs) integrated on the LCD circuit board. LCD's pin E (Enable) is connected to digital pin 11 on the Arduino board. Pin RS (Register Select) on the LCD is connected to Arduino digital pin 12. R/W pin of the LCD is connected to GND (ground). Fig.3 shows the LCD-microcontroller interface.

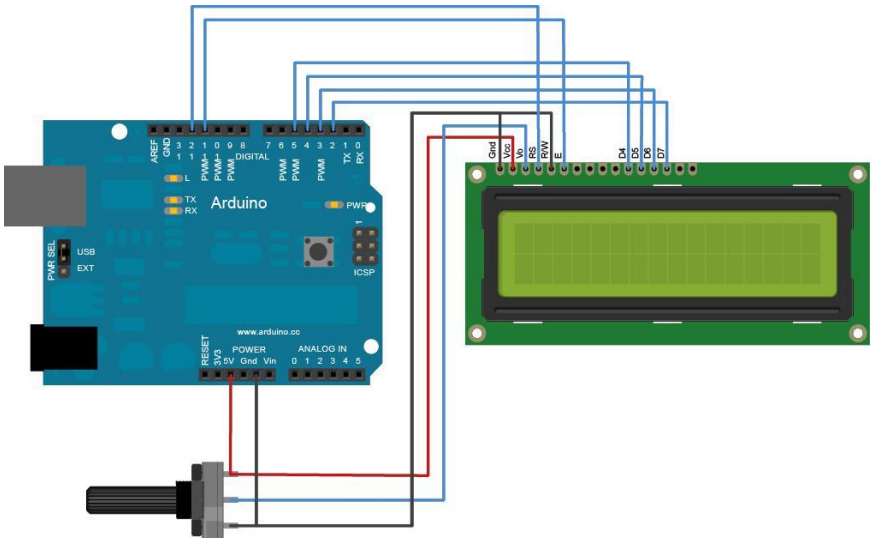

Figure 3. LCD Connection to Arduino board

2.1.3.2 Light Emitting Diodes(LEDS)

To indicate the three states of the soil, three LEDs are used. The three LEDs lit up depending on the soil moisture content. When the soil is dry, LED connected to Arduino digital pin 13 is lit. For moist soil (required condition), LED connected to Arduino digital pin 12 lit up and for soggy soil, LED connected to Arduino digital pin 11 lit up. The three LEDs are connected to the microcontroller as shown in Fig.4.

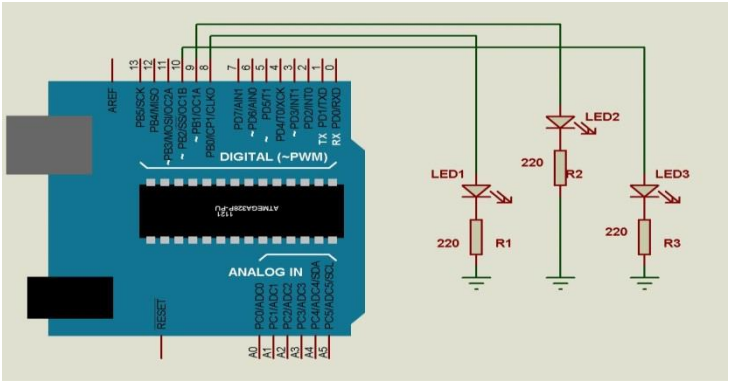

Figure 4. LEDs Connection to Arduino board

Ohms law is utilized to determine the size (in ohms) of the protection resistor to be interfaced with the LEDs. From Ohms law

$$\text{Voltage (V)} = \{\text{Current (I)}\}*\{\text{Resistance(R)}\} \quad \ldots\ldots\ldots(2)$$

Where as in our case;

V= Vcc (5V) -Voltage drop across LED (selected LEDs has 2.0V) …….(3)

I_{LED}= LED current (20mA) …… (4)

V_{LED} = LED Voltage drop (red in colour) (2V) …….. (5)

R= minimum required resistance value

Therefore

$$R_{min} = \{(5-2)\ V\}/\ \{20mA\} = 150\ \Omega \quad \ldots\ldots\ldots.. (6)$$

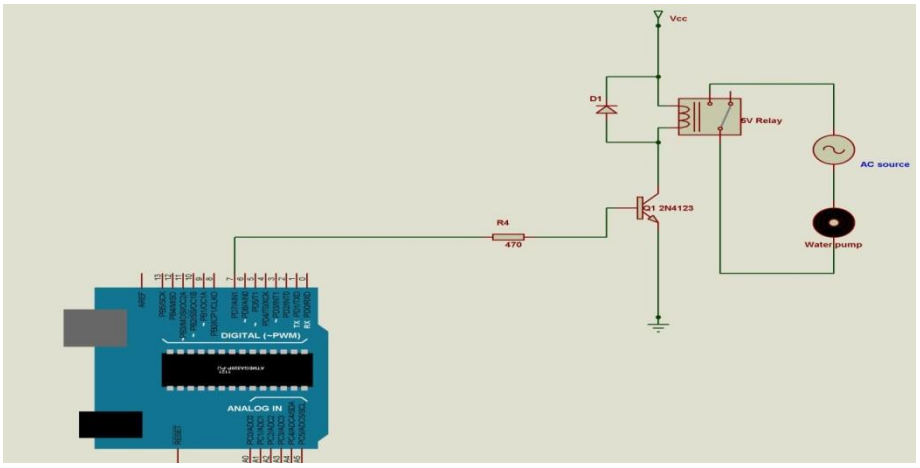

Figure 5. Relay interfacing of Arduino to the 240 VAC pump

To achieve current limitation a resistance value higher than the calculated R_{min} is selected. A 220Ω resistor is used and thus only 13.6mA current is allowed to pass through each of the three LEDs.

2.1.3.3 Water Pump Connection to the Arduino

To implement the final bit of the automated irrigation system, an electric motor (240VAC) is selected as the water pump. The first two units of the system i.e. sensing unit and the control unit (microcontroller) are powered by 5VDC. To interface the two units, a 5VDC relay (SLT73-5D-1Z) is used as the isolation unit.

The microcontroller is connected to the relay via an NPN transistor (2N4123). To protect the transistor; while turning it on, a resistor is used. The resistor limits the current flowing through the transistor. As is the case with LEDs, ohms law is used as shown below.

$$R_{min} = (5 - 0.7)\ V / 40mA = 107.5\Omega \quad \text{……. (7)}$$

A resistor of 470Ω is selected and thus the current through the transistor is limited to;

$$4.3V / 470\Omega = 9.12\ mA \quad \text{…… (8)}$$

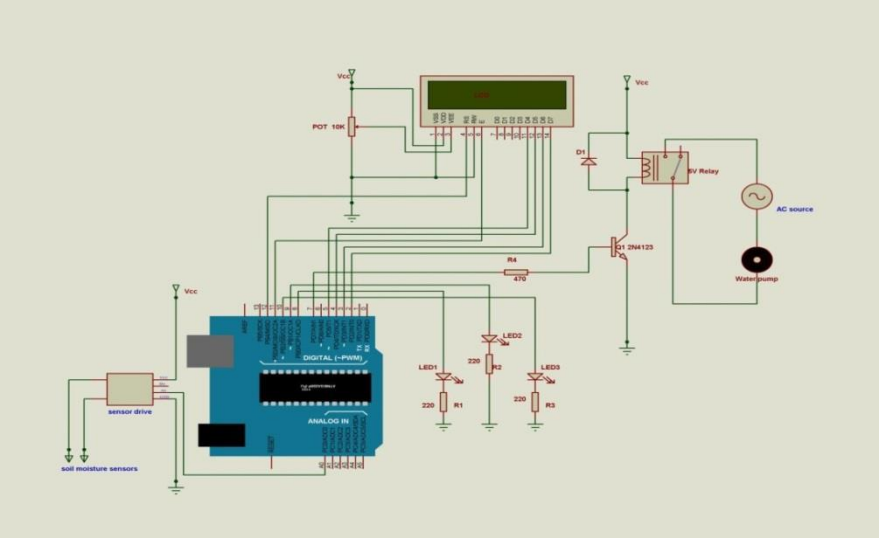

Figure 6. Circuit with all the components and parts

To protect the microcontroller from back e.m.f during switching, a diode is connected across the relay. The connection is as shown in Fig.5. The complete design is shown in Fig.6

2.2 Software Design

To be able to interpret the different states of the soil as prompted by the soil sensor, the microcontroller is programmed. The Arduino integrated development environment (IDE) is used. The idea is based on C++ and thus can be extended using C++ libraries. Arduino programs (sketches) are cross platform, simple, clear and at the same time flexible for advanced programmers.

2.2.1 Program Pseudo Code

The instructions of program pseudo code are given below, while, Fig.7 shows the flowchart

READ sensorvalue
COMPARE sensorvalue with set threshold
IF sensorvalue > maximum set value TURN-ON pump
DISPLAY soil condition on LCD
LIGHT dry soil LED
ELSE IF sensorvalue < maximum set
value > minimum set value TURN OFF pump
DISPLAY soil condition on LCD
LIGHT moist soil LED
ELSE IF sensorvalue < minimum set value TURN-OFF pump
DISPLAY soil condition on LCD
LIGHT soggy soil LED

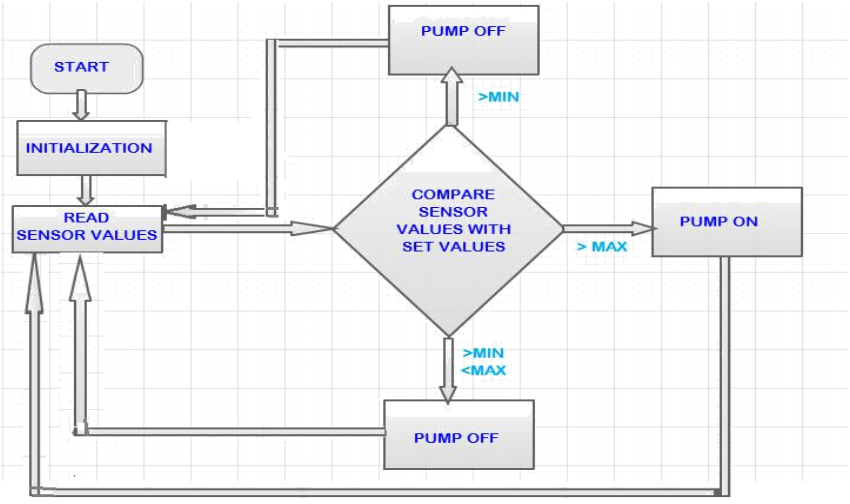

Figure 7. Flow chart

RESULTS AND DISCUSSION

3.1 Results

The volumetric water content (VWC) of sand soil, red soil and black soils are calculated. The raw data collected from the soil moisture sensor is recorded as shown in Table 4. The soil is measured in equal amount of 250 g. Water is added in the soils in steps and the sensor values recorded.

Table 4. Sensor values

Soil water content (cm3)	*Sensor Reading*		
	Loam soil	*Sand soil*	*Red soil*
0	*1021*	*1022*	*1020*
50	*580*	*546*	*781*
75	*360*	*234*	*568*
100	*237*	*243*	*295*
125	*203*	*184*	*274*
150	*191*	*180*	*235*
175	*180*	*170*	*220*

3.2 Discussion

The data obtained from the sensor reading and recorded in Table 4 is used to plot a graph of soil water content against sensor reading as shown in Fig.8.

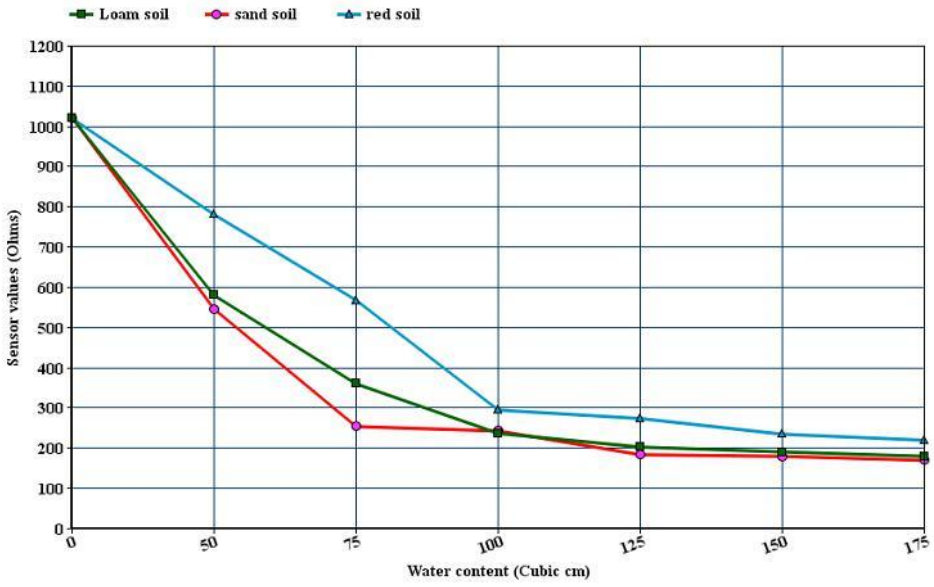

Figure 8. Sensor reading against water content

The soil moisture sensor (SMS) and (YL-69) used is a resistance sensor type. Its output is the resistance in the soil between the two SMS probes. The obtained graph is an exponential one. The value of the soil resistance decreases with increase in water content to a certain point.

To come up with the results, the three soils are dried using a frying pan until all the moisture content is lost. 250 grams is measured for the red soil, black soil and the sand soil. Water is added in steps of 25cm^3 and sensor value recorded.

The value of soil sensor at dry soil is almost equal for the three soils at 1021, 1022, 1020 for black soil, sand soil and red soil respectively. On adding 50cm^3, the resistance value reduced drastically to the range of 500. On adding more water the resistance value kept reducing.

At around 100 cm^3, of water the reduction on the soil resistance stated reducing at a much lower rate. This is because at this point the soil is now becoming saturated with water and thus adding more water has a small effect on the soil resistance.

The sensor is calibrated and three states defined. The states are soggy, moist and dry. When the dry state is achieved, the control unit (microcontroller) switched the water pump on via a relay circuit. The three states are indicated using three different LEDs and an LCD. The LCD also indicated when the pump is running.

The control circuit and the sensor circuit are powered using a 9V alkaline battery which is connected via a voltage regulator with an output of 5V.

CONCLUSION

A system to monitor moisture levels in the soil was designed. The system was used to switch on/off the watering system/pump according to set soil moisture levels. The control unit was implemented using a microcontroller on Arduino platform while the sensing bit was implemented using a SMS YL-69. Three LEDs and an LCD were used to implement the display of the three soil states i.e. soggy soil, moist soil and the dry soil states. To switch between the control and the irrigation systems, a relay switching circuit was used.

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IRIGACIONI SISTEM KONTROLISAN SA ARDUINO UNO MIKROKONTROLEROM

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Sažetak. U ratarskoj proizvodnji dobar balans (raspored) vode je neophodan za prinose visokog kvaliteta. Usevi koji nisu snabdeveni potrebnom količinom vode navodnjavaju se i zbog nedostatka hranjivih sastojaka, ali suviše navodnjavane biljke su podložne pritisku i pojavi bolesti i mogu u nekim slučajevima dovesti do propadanja korena biljke zbog gušenja. Takođe, prekomerno navodnjavane biljke ne mogu kasnije da izdrže posledice sušne sezone.

Cilj ovog rada je korišćenje inžinjerskih principa i koncepta za kontrolu sistema za navodnjavanje upotrebom određenog mikrokontrolera. Sistem pomaže u uštedi vode i novca i tako istovremeno značajno povećava proizvodnju, prinos useva.

Automatski sistem za navodnjavanje se kontroliše i upravlja sa mikrokontrolerom tipa ATmega328 koji je zasnovan na osnovu otvorene platforme Arduino Software .
Sistem se programira sa mikrokontrolerom kako bi sistem za navodnjavanje (kapljači, rasprskivači, itd.) dobio potreban signal koji zavisi od sadržaja vlage zemljišta.
Sadržaj vlage u zemljištu se proverava pomoću senzora za vlagu u zemljištu i kada dođe do promene vlažnosti zemljišta, ovaj senzor registruje vrednost promene i šalje odgovarajući prekidni signal mikrokontroleru ATmega328 koji sistem za navodnjavanje (pumpe) aktivira ili deaktivira.

Ključne reči: *Sistem za navodnjavanje, mikrokontroler.*

Prijavljen: *Submitted*:	15.07.2019.
Ispravljen: *Revised*:	10.02.2020.
Prihvaćen: *Accepted*:	12.02.2020.

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POLJOPRIVREDNA TEHNIKA
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Year XLV
No. 2, 2020.
pp: 79 – 87

UDK: 631.563:662.612:633.15

Original scientific paper
Originalni naučni rad
doi: 10.5937/PoljTeh2002079A

MEASUREMENT BRIDGE FOR LARGE GRAIN MOISTURE CONTENT DETERMINATION

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Abstract: This paper describes the development of a moisture-measuring instrument suitable for large grains. The paper seeks to do the measurement based on the propagation of microwaves through materials of different moisture levels. The principle of operation here is sending an equally divided signal through both arms of the bridge and comparing the output signals' properties to determine the moisture content of the grains. The design of the bridge using waveguide and coax technology is presented.

Key words*: Measurement bridge, grain moisture content determination, waveguide*.

INTRODUCTION

A waveguide is a structure that guides waves, such as electromagnetic or sound waves. There are different types of waveguides for each type of wave. The original and most common is a hollow conductive metal pipe used to carry high frequency radio waves, particularly microwaves.

The geometry of a waveguide reflects its function. Slab waveguides confine energy to travel only in one dimension, fiber or channel waveguides for two dimensions. The frequency of the transmitted wave also dictates the shape of a waveguide; an optical fiber guiding high-frequency light will not guide microwaves of a much lower frequency. The width of a waveguide needs to be of the same order of magnitude as the wavelength of the guided wave.

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Waves propagate in all directions in open space as spherical waves. The power of the wave falls with the distance *R* from the source as the square of the distance. A waveguide confines the wave to propagate in one dimension, so that, under ideal conditions, the wave loses no power while propagating. The conductors generally used in waveguides have small skin depth and hence large surface conductance. Due to total reflection at the walls, waves are confined to the interior of a waveguide. The propagation inside the waveguide, hence, can be described approximately as a "zigzag" between the walls. This description is exact for electromagnetic waves in a hollow metal tube with a rectangular or circular cross-section.

Microwaves have made their applications in various areas; and have been used in moisture content determination. This has been an improvement from the traditional methods where the sample, in this case grains had to be dried in order to determine the moisture content. This meant the methods used earlier were destructive and it was not possible to recover the sample. Microwaves are a non-destructive method for determining the moisture level of grains. The sample is recovered as was before being used.

Product quality assurance especially in the agricultural sector is a challenge especially in processing industries. Moisture content in grains can also lead to great losses due to the weight of the water content and also fungal infections in grains which could lead to great losses for farmers.

The paper objective is to accurately determine the moisture content in grains by determining the attenuation and phase and their relationship with dielectric constant/relative permittivity of microwaves when transmitted through the sample. Some researches that discuss the topic of this paper can be found in literatures[1-5].

2- System design

The design specifications define the working of a bridge at microwave frequencies. The bridge is designed using microstrip and coax technology. The input signal is taken through a power splitter which splits the power into equal halves. Each side of the bridge has a cavity fed by the microstrip transmission line. The lower arm is used as the datum and samples placed in the cavity of other arm. The output signals from either arm are then mixed and filtered to obtain the output signal.

2.1 Design of power splitter

Wilkinson splitter shown in Fig.1 works as a power divider, when a signal enters port 1, it splits into equal-amplitude, equal-phase output signals at ports 2 and 3. Since each end of the isolation resistor between ports 2 and 3 is at the same potential, no current flows through it and therefore the resistor is decoupled from the input.

The two output port terminations will add in parallel at the input, so they must be transformed to $2xZ_0$ each at the input port to combine to Z_0. The quarter-wave transformers in each leg accomplish this; without the quarter-wave transformers, the combined impedance of the two outputs at port 1 would be $Z_0/2$. The characteristic impedance of the quarter-wave lines must be equal to $1.414xZ_0$ so that the input is matched when ports 2 and 3 are terminated in Z_0.

The signal from the input is equally divided between the two arms of the Wilkinson power divider before being fed to the microstrip transmission line. The practical circuit of Wilkinson splitter is shown in Fig.2.

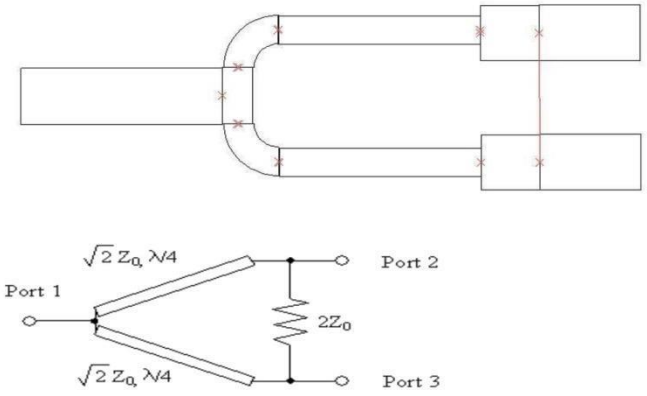

Figure 1. Wilkinson splitter

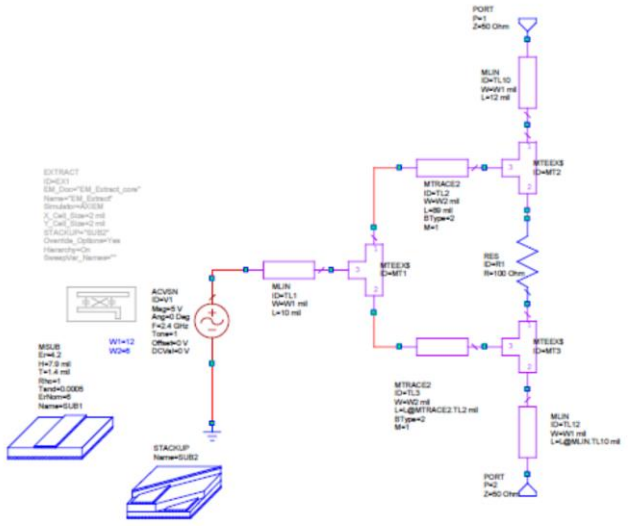

Figure 2. Practical Circuit of Wilkinson splitter

2.2 Design of microstrip transmission line

The microstrip design includs determination of the various parameters for optimal working condition of the line. Microwave office offers a design window for specifying the various parameters of the microstrip. The parameters to be specified include the following:

- Operating frequency
- Electrical length
- Impedance
- Dielectric constant
- Dielectric

The length, width, height and thickness of the microstrip can then be obtained from the parameters specified above.

The sub-circuit in Fig.3 shows the power splitter and the microstrip line. The parameters for the line are specified and the substrate values given also for each m-sub.

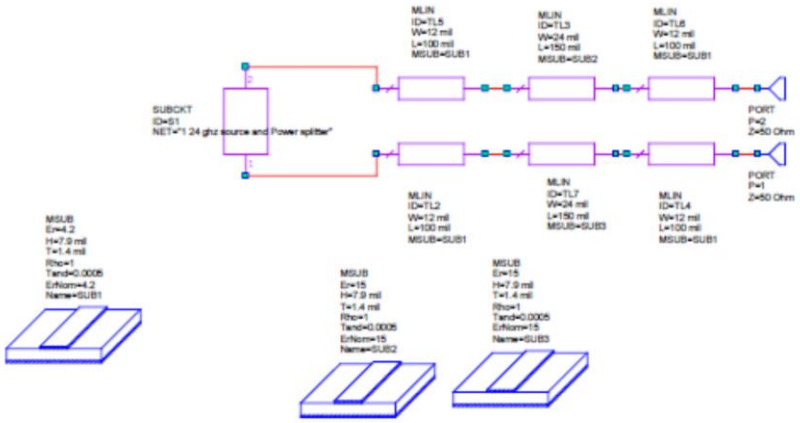

Figure 3. Power splitter and micro strip line

2.3 Design of the cavity

The design of the cavity involves determination of the sample holder parameters for optimal working conditions. The cavity parameters are determined using mathematical computations. Two cavities, one in each arm are used in the circuit. One cavity is maintained as the datum and the other cavity is where the grains whose moisture is to be determined are placed. The signal outputs from the cavity are then transmitted by the microstrip line to the mixer.

2.4 Design of mixer

The mixer in the circuit works to multiply the signals from either arm of the bridge and produce a single output whose properties are dependent on the two input signals.

The ideal mixer, is a device which multiplies two input signals. If the inputs are sinusoids, the ideal mixer output is the sum and difference frequencies, typically, either the sum, or the difference frequency is removed with a filter.

Important properties of the mixer that are put into consideration in the design of the mixer include:

- Conversion gain or loss - lowers the noise impact of following stages.
- Intercept point (linearity) - impacts receiver blocking and interferer performance.
- Ports isolation (LO-to-RF, LO-to-IF, RF-to-IF) - want to minimize interaction between the RF, IF, and LO ports.
- Noise figure - impacts receiver sensitivity.
- High-order spurious response rejection.
- Image noise suppression – improves system noise figure.
- Operating frequency range.

The circuit showing the mixer specifications and the two signals being fed to it is as shown in Fig.4.

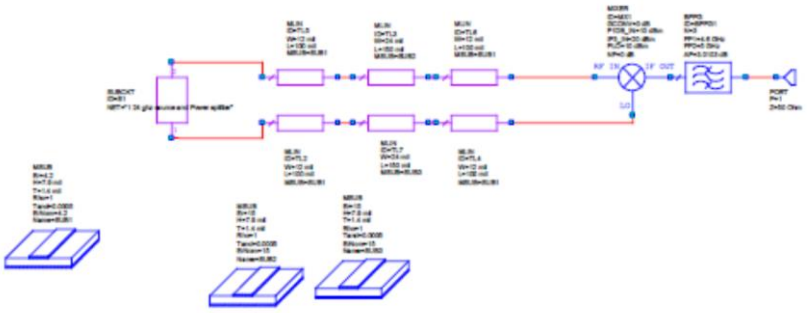

Figure 4. Mixer circuit

3. Simulation results

3.1 Power splitter analysis

Simulation results for the power splitter showing the power being split into two equal halves as shown in Fig.5.

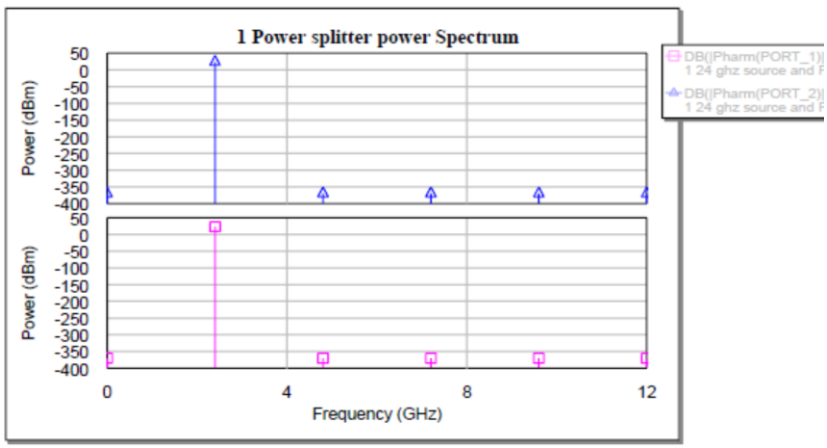

Figure 5. Power splitter result

3.2 Output from power splitter and transmission line

With both cavities empty (having the same value of dielectric) simulated results shown in Fig.6 indicate equal distribution of power in each arm of the bridge.

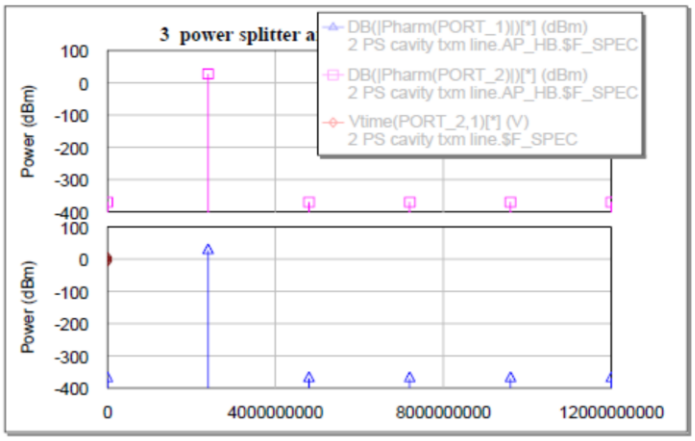

Figure 6. Output from power splitter and transmission line

3.3 Output voltage from mixer

The output voltage from the mixer is shown in Fig.7.

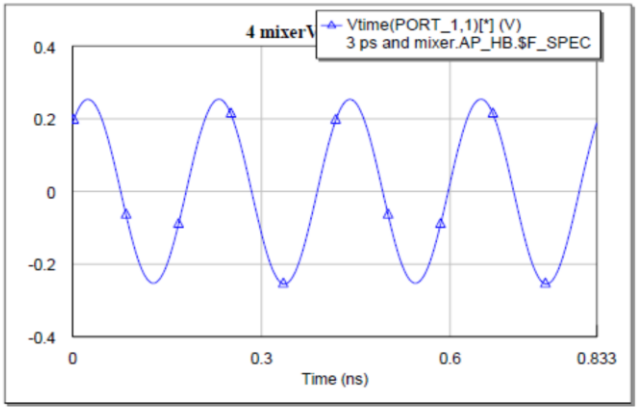

Figure 7. Output voltage

3.4 Output graph

3.4.1 Relationship between phase shift and dielectric constant

Variation of dielectric constant results in shifting of the phase of the two signals as shown in Fig.8.

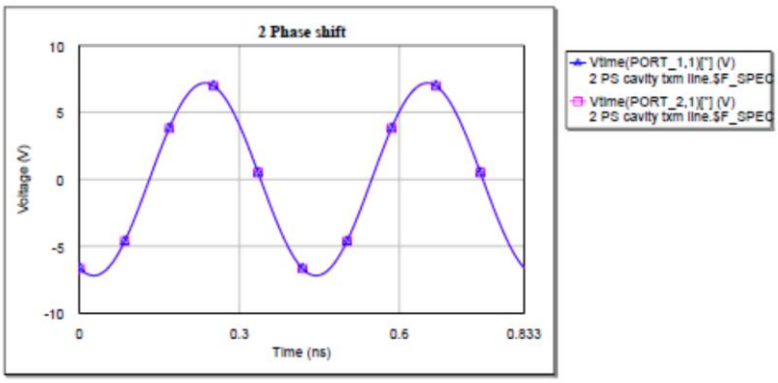

Figure 8. Results showing the phase shift of the two signals

3.4.2 Graph of phase against dielectric constant

The relationship between phase and dielectric constant is shown in Fig.9.

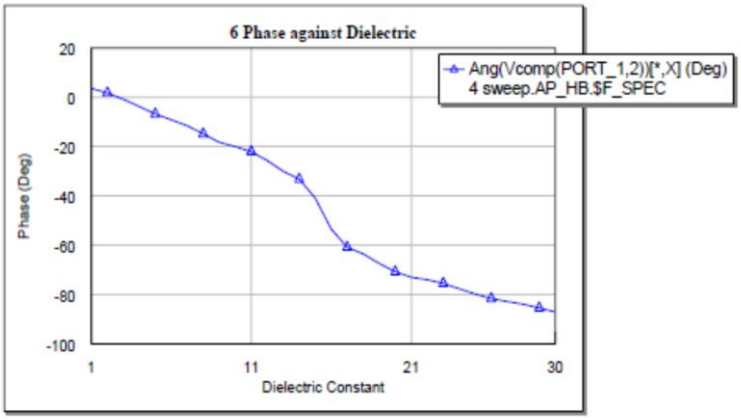

Figure 9. Relation between phase and dielectric constant

3.4.3 Graph of dielectric constant against power

The relationship between dielectric constant and power is shown in Fig.10.

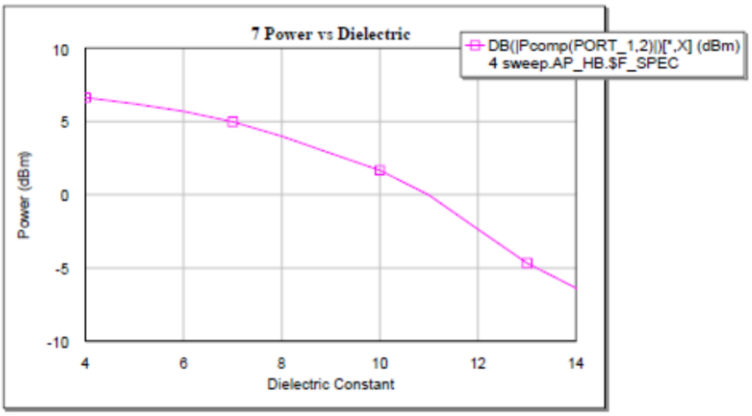

Figure 10. Relation between power and dielectric constant

CONCLUSIONS

The objectives of the paper were met though with several challenges. It was successfully observed that microwaves and waveguide technology would be an effective method to determine the moisture content in grains without destruction of the grain samples.

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MERNI MOST ZA ODREĐIVANJE SADRŽAJA VLAGE ZA VELIKE KOLIČINE ZRNA

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Sažetak. Ovaj rad opisuje razvoj pogodnog instrumenta za merenje sadržaja vlage u velikim količinama zrna (npr. skladišta, silosi). U radu se prikazuje merenje na osnovu prostiranja mikrotalasa kroz zrnaste ili slične materijale u masi različitih sadržaja vlage. Princip rada instrumenta je slanje podjednakih signala kroz oba kraka mernog mosta i upoređivanje osobina izlaznih signala radi određivanja sadržaja vlage u masi zrna. Predstavljen je dizajn mernog mosta sa korišćenjem prostiranja talasa kroz cevi i tehnologija koaksijalnih (optičkih) kablova .

Ključne reči: *Merni most, određivanje sadržaja vlage u zrnu, talas*

Prijavljen: *Submitted*:	14.07.2019.
Ispravljen: *Revised*:	02.02.2020.
Prihvaćen: *Accepted*:	25.05.2020.

CIP Каталогизација у публикацији
Народна библиотека Србије, Београд
631(059)
ПОЉОПРИВРЕДНА техника : научни часопис =
Agricultural Engineering : Scientific Journal /
одговорни уредник Мићо В. Ољача – Год. 1, бр. 1
(1963)- . - Београд; Земун : Институт за пољопривредну
технику, 1963- (Београд : Штампарија : PRINT-M,
Београд) . – 25 cm
Тромесечно. – Прекид у излажењуод 1987-1997. године
ISSN 0554-5587 = Пољопривредна техника
COBISS.SR-ID 16398594