JAET

Journal homepage: http://jae-tech,com

Journal of Applied Engineering & Technology

ISSN : 2523-6032 ISSN-L : 2523-2924

DESIGN AND ANALYSIS OF VARIOUS COMPONENTS OF LEPTOCHLOA FUSCA PELLETIZING MACHINE

Sunny Kumar Advani[*,1], Dur Muhammad Pathan[1], Muhammad Sharif Jamali[1], Zain-ul-Abdin Qureshi[1], Ans Ahmed Memon[1]

[1]Department of Mechanical Engineering, Mehran University of Engineering and Technology, Jamshoro, 76060, PAKISTAN.

*Corresponding Author: Sunny Kumar Advani

DOI: **https://doi.org/10.55447/jaet.06.01.61**

Abstract: This project places a strong emphasis on the development of agriculture-based technology, which will motivate farmers and owners of subpar property to raise cattle. The paper discusses the material safety factor and fatigue life for manufacturing of pelletizing machine for leptochloa fusca. The emphasis of this technology is to pelletize the leptochloa fusca (Kallar Grass). The initiative focuses on the advancement of agriculturally based technology. The fatigue life and factor of safety of the main components of the pelletizing machine were examined in ANSYS software by using a sample of SolidWorks. Analysis of factor of safety and fatigue life represents that material is safe and can undergo 1×10^6 cyclic load, hence material is safe for the manufacturing of pelletizing machine for leptochloa fusca.

Keywords: CAD Model, Finite Element Analysis (FEA), Design and analysis.

1. Introduction

The primary raw material for this paper and pelletizing equipment is leptochloa fusca. Includes a high nutritional content and a low cost of cultivation, leptochloa fusca was discovered to be the strongest feed for cattle. However, due to its hardness, it is challenging to break or touch with the hand. The proposed technology makes it possible to pelletize the grass and give it to animals without having to deal with that problem. Additionally, it has been noticed that saline soil transforms into fertile soil after four to five years of constant cultivation. Additionally unnecessary activities like loading and unloading can be reduced, along with the expenditures on transportation and gasoline. Although there are various pelletizers in the market, the suggested device is intended exclusively for Kallar grass (Leptochloa Fusca).

The pellet mill will encounter numerous issues, including problems locating spare parts, high maintenance costs and a need for qualified technicians if it is embraced in the market and used in small to medium-sized businesses. In other words, a locally produced pellet mill that is both economically sound and technically sound.

This research was carried out to boost the operational performance of the pellet mill at a lower cost. The type of pellet mill that was designed and analysed in this study has fixed dies and stationary rollers that rotated at the shaft. This mechanism uses a mix of centrifugal and rotational forces. The connecting rod, shaft, roller, and die were the pellet mill's primary components. The research aims to design and analyse pellet mill parts with integrated sizes that would eliminate costs by utilizing a commercially available material with minimal maintenance costs. The effectiveness of several types of pelletizers has been devised and examined by many researchers for a variety of purposes, including the production of charcoal from low-density wood, fish, fruit, oil palm, rice husk and coconut shell.

Corresponding author: k_sunny48@yahoo.com
2022 JAET. All rights reserved.

1.1 Problem Statement

Wheat straw is usually used as feed for livestock, however its nutritional value is low and cost of cultivation is high, where the leptochloa fusca has high nutritional value and low cultivation cost but the problem is that leptochloa fusca is hard. Therefore, it cannot be touched with hand and animals cannot eat it without pelletizing. To utilize such grass as feed for livestock, there is need of pelletizing machine. There are various pelletizing machines available in market but there is no any pelletizing machine available for the pelletizing the leptochloa fusca to use as feed for livestock. Before the fabrication of any components of pelletizing machine for leptochloa fusca, it is necessary to analyse the components as per specification of grass (*Leptochloa Fusca*).

2. Background and Literature Review

Since there are several kinds of pelletizing machines that can be used to pelletize waste biomaterials, wood, sawdust, fish food etc. In the current study, the components for leptochloa fusca (Kallar grass) pelletizing machine are designed and analysed, where the fatigue life and material safety factor produced within the primary pelletizing machine components (roller, die, shaft, and connecting rod) are analysed by using ANSYS software. The biggest issue with pelletizing machine is that only one type of grass gets pelletized at a time. Leptochloa fusca, a cheap and potent grass that may be used as livestock feed and has a higher metabolizable energy content than wheat straw, it is not the subject of any machinery yet. Where it is also observed that leptochloa fusca is harder and cannot be cut or touched by hand. Dual powered (electrical and manual power) mini pelletizing machine was designed and fabricated [1].

To avoid the expensive cost of importing, the prototype of feed pelletizer was designed and fabricated, which uses little energy [2]. The fish feed pelletizing machine was designed and fabricated [3]. It is significant from two perspectives: first, because it is a local machine, and second, because it produces pellets for both domestic and international markets. The machine was designed for complete grazing grass ring [4]. A pellet mill with a ring mold has been designed but it needs 15 hp, which is high energy [5]. To improve biomass density and produce high-quality pellets, pelletizing machine was desugned which consists of three main unit operations: drying, size reduction (grinding), and densification [6]. A machine was fabricated with a simplified operating system to produce a specific feed [7].

A screw press pelletizing machine was manufactured for waste biomass materials like oil palm wastes to create pellets from a powder or molten mixture [8]. A method was provided for quick and inexpensive evaluation of pellet quality that can be applied throughout the supply chain [9]. A machine for making cassava mash pellets at a cottage level was designed, fabricated and tested [10]. A machine was designed for pelletizing biomass [11]. Very little research for the design and analysis of a pelletizing machine for Leptochloa fusca is identified in the literature, that is currently available. As a result, the design and analysis of leptochloa fusca pelletizing machine components will be the main emphasis of this study.

3. Research Methodology

The components of pelletizing machine and designed parameters will be chosen in order to accomplish the research goal. The parts of the pelletizing machine, such as the roller, die, shaft, and connecting rod will be developed independently. The 3D model is loaded into the ANSYS program for finite element analysis, applying loads around it and analysis. After analysis is completed, the loads of those components are transferred to ANSYS software to predict fatigue life and factor of safety. Following methos is followed to accomplish the research work.

(i) Literature review
(ii) Finding the design parameters (Hole size, profile, hay cut size and thickness)
(iii) Design of components by using SolidWorks software.
(iv) Analysis of components by using ANSYS software.

Here the flow chart diagram of research methodology is given below:

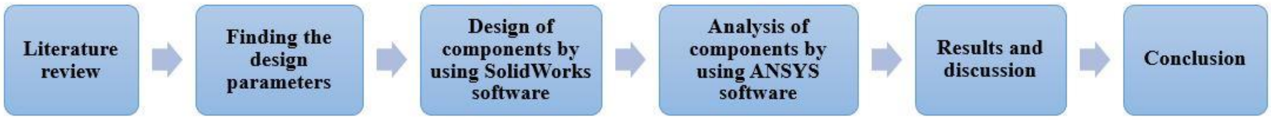

Fig: 1 Flow chart diagram of research methodology

3.1 CAD Modelling of Machine Components:

SolidWorks software was used to create the 3D model of the roller, die, shaft, and connecting rod used in pelletizing machines. Three-dimensional components are created after 2D is created. The tables No. 1 and No. 2 given below provides the design specifications for the roller, die, shaft, and connecting rod of the pelletizing machine. The 3D CAD model are represented in fig 2, 3, 4 and 5 respectively. Where the fig 4 and 5 represents the shaft and connecting rod to engage the roller and die with each other for working condition.

Table 1 (a): Specification of roller and die for pelletizing machine

Geometry of Roller		Geometry of Die	
Parameters	**Dimension**	**Parameters**	**Dimension**
Roller diameter	90 mm	Diameter of die	200 mm
Roller width	50 mm	Thickness of Die	24.30 mm
Roller hole diameter	30 mm	Centre hole diameter	20 mm
Chamfer size	03 mm	Cut size hole diameter	08 mm
No. of roller blades	25	Radial gape in die holes	10 mm
		No of die hole	148

Table 1 (b): Specification of shaft and connecting rod for pelletizing machine

Geometry of Shaft		Geometry of Connecting Rod	
Parameters	**Dimension**	**Parameters**	**Dimension**
Shaft length	120 mm	Rod length	134.30 mm
Shaft rod diameter	30 mm	Length of keyways	50 mm
Shaft middle part length	50 mm	Width of keyways	05 mm
No. of shaft keyways for connecting rod	06		
Length of shaft keyways	50 mm		
Width of shaft groves/keyways	5 mm		

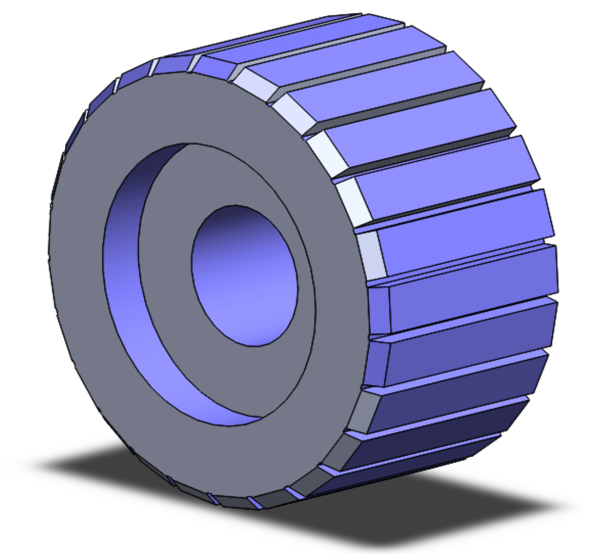

Fig: 2 CAD Model of Roller

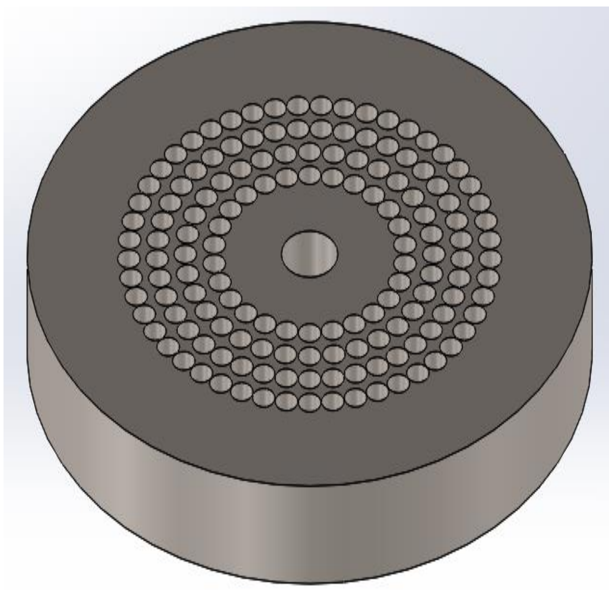

Fig: 3 CAD Model of Die

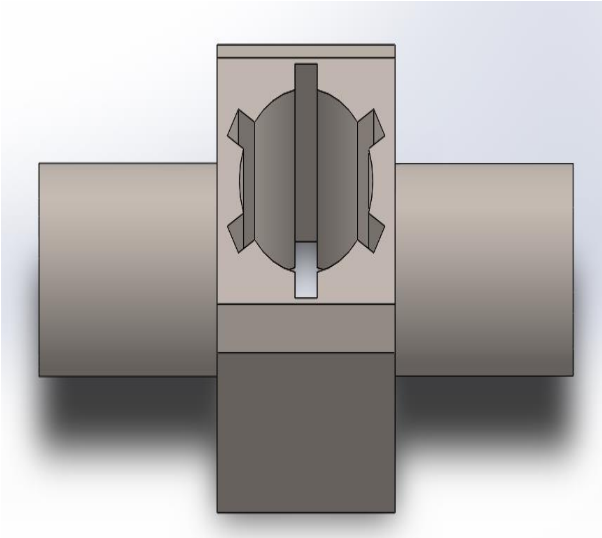

Fig: 4 CAD Model of Shaft

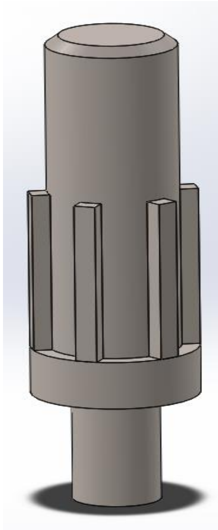

Fig: 4 CAD Model of Connecting Rod

Fig 2 shows the 3D CAD model of die for cut the grass and making pellets, fig 3 shows the roller which compresses the grass for pelletization, fig 4 represents the shaft for connecting the roller at both ends and fig 5 represents the connecting rod which works to connect the die and shaft and is connected with motor for working condition and suppling power to produce the pellets.

4. Results and Discussion

Roller, die, shaft, and connecting rod are among the major pelletizing machine components that are designed in SolidWorks software and analysed in ANSYS software. Numerous metrics, including fatigue life analysis and factor of safety are analysed using the ANSYS software.

4.1 Factor of Safety Analysis of Components

Analysed results of roller, die, shaft and connecting rod are presented in terms of factor of safety at applied load. The material used for the components was structural steel, where the total weight of components and applied load is given in table 2 and material's factor of safety for components are represented in fig 6, 7, 8 and 9 respectively.

Table 2: Total weight of components and applied load

Component Name	Total Weight	Applied Load
Roller	22.86 N	5 N
Die	43.95 N	62 N
Shaft	8.73 N	45.72 N
Connecting Rod	7.995 N	54.45 N

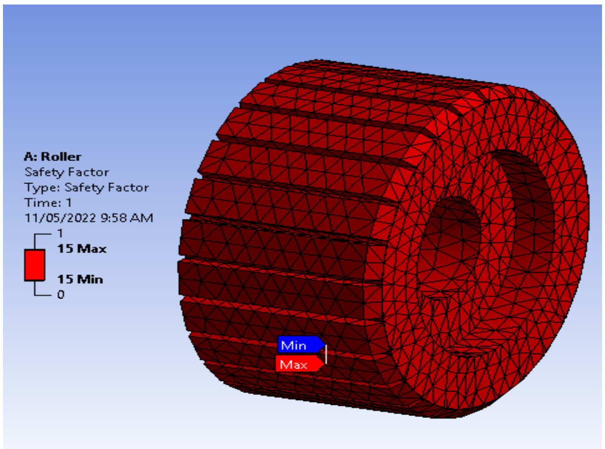

Fig: 6 Factor of safety of roller

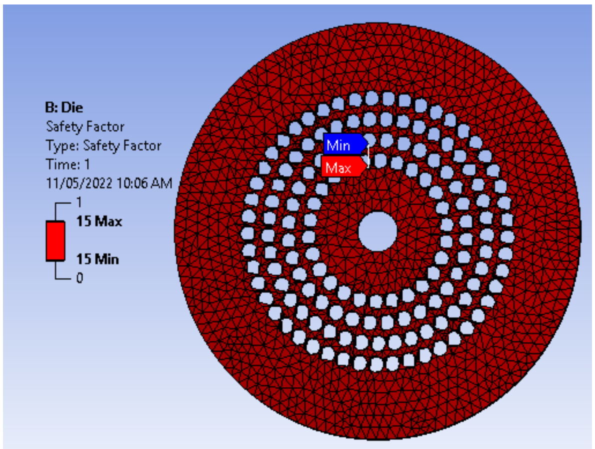

Fig: 7 Factor of safety of die

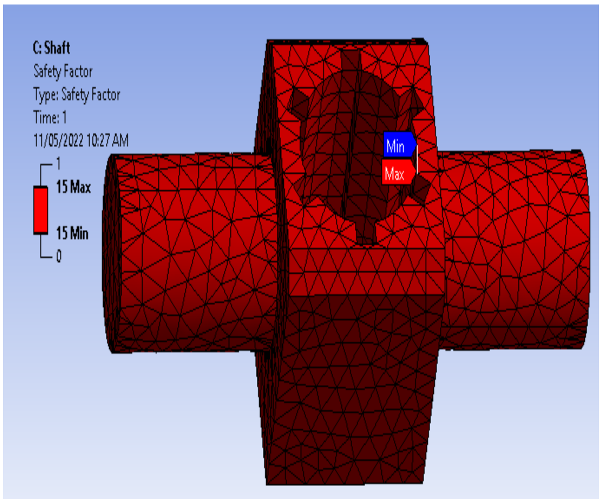

Fig: 8 Factor of safety of shaft

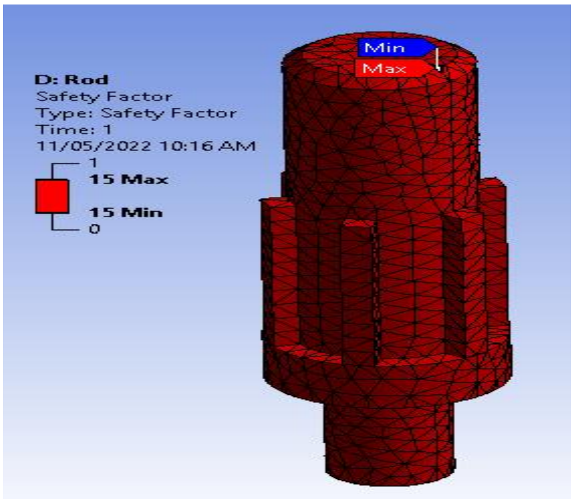

Fig: 9 Factor of safety of Connecting Rod

Figs: 5, 6, 7 and 8 shows that factor of safety is greater than 0 and less than 1, which results that factor of safety is normal and lies between the range of 0 and 1, hence material is safe and can be utilized.

4.2 Fatigue Life Analysis of Components

Analysed results of roller, die, shaft and connecting rod are presented in terms of fatigue life at applied load. The material used for the components was structural steel, where the total weight of components and applied load is given in table 2 and material's fatigue life for components are represented in fig 10, 11, 12 and 13 respectively.

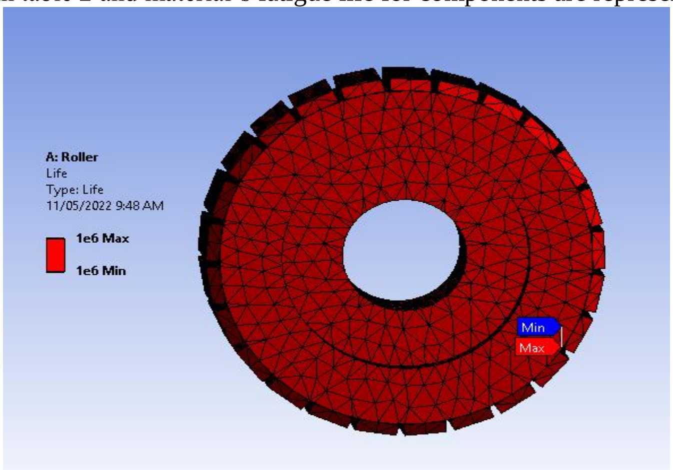

Fig: 10 Fatigue life of safety of roller

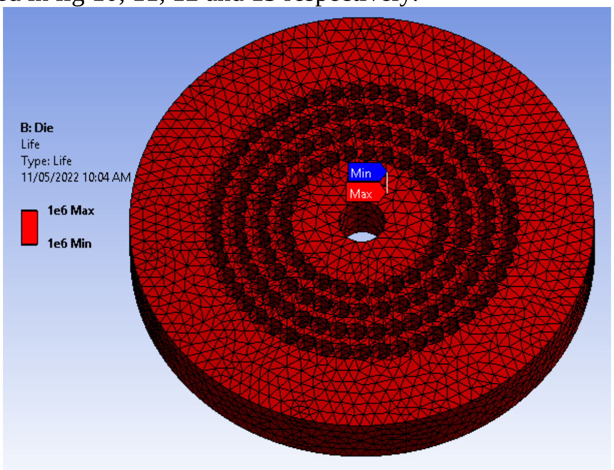

Fig: 11Fatigue life of safety of die

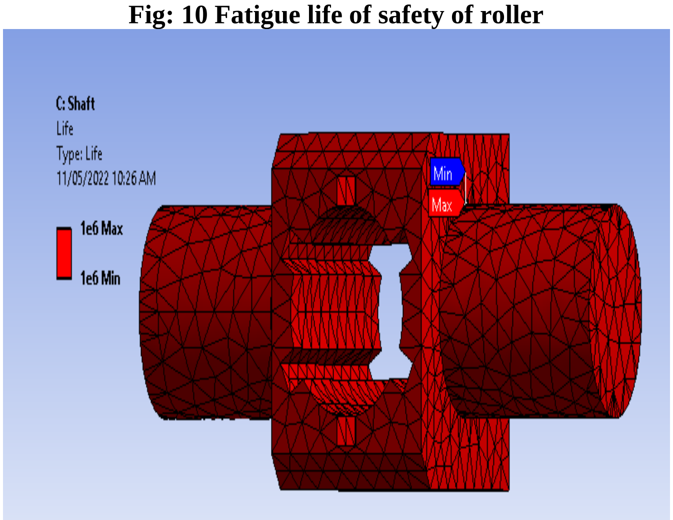

Fig: 12 Fatigue life of shaft

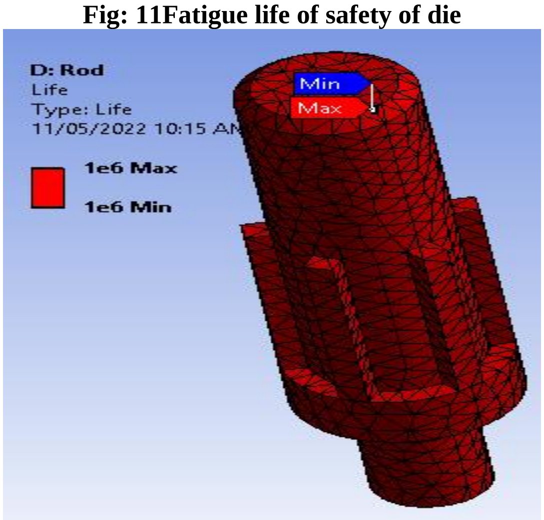

Fig: 13 Fatigue life of connecting rod

Figs: 9, 10, 11 and 12 shows that fatigue life of material is 1×10^6, which results that fatigue life is normal and material can undergo 1×10^6 cyclic load, hence material is safe and can be utilized.

5. Conclusion

The purpose of this study is to design a Leptochloa Fusca grass pelletizing machine. It is concluded by obtained results that the major pelletizing machine components (roller, die, shaft, and connecting rod) are designed such that they have normal factor of safety and fatigue life at the appropriate load. The factor of safety and fatigue life is normal for all major components. Where the factor of safety lies between 0 to 1 and fatigue life of material is 1×10^6. As a result, the parts are safe and can be used for pelletizing machine for leptochloa fusca.

Acknowledgement

First and foremost, I would like to express my sincere thanks to **Prof. Dr. Dur Muhammad Pathan, Engr. Muhammad Sharif Jamali, Prof. Dr. Tanweer Hussain** and **Engr. Intizar Ali Tunio** for their endless support, encouragement and inspiration throughout my research work. Thank you for providing me the liberty and reassurance to take this research in new directions. You guided me whenever I needed guidance and made this research journey memorable.

I also owe my special thanks to **Dr. Laveet Kumar, Engr. Ans Ahmed Memon and Engr. Muhammad Waqas Chandio** for their continuous support, help and encouragement to accomplish this research work.

References

[1] Sonkhaskar, Y. M., Deshpande, V. S., & Modak, J. P. (2014). Design and Fabrication of a Dual Powered Mini Pelletizer. In Applied Mechanics and Materials (Vol. 465, pp. 242-247). Trans Tech Publications Ltd.

[2] Abubakre, O. K., Garba, A. B., & Tukur, H. (2014). Design and fabrication of model feed pelletizer. In Applied Mechanics and Materials (Vol. 533, pp. 64-67). Trans Tech Publications Ltd.

[3] Okolie, P. C., Chukwujike, I. C., Chukwuneke, J. L., & Dara, J. E. (2019). Design and production of a fish feed pelletizing machine. Heliyon, 5(6), e02001.

[4] Tang, D., Wang, G., Wang, D., He, C., He, G., Fu, J., & Chan, Q. (2016). An Optimization Design of Forage Grass Ring-die Pelletizing Machine. In 2016 ASABE Annual International Meeting (p. 1). American Society of Agricultural and Biological Engineers.

[5] Wei, G., Tabil, L. G., Rongfei, Z., & Qingyu, L. (2016). Optimized design and experiment on ring mold pelletizer for producing biomass fuel pellets. International Journal of Agricultural and Biological Engineering, 9(3), 57-66.

[6] Renjani, R. A., & Wulandani, D. (2019, June). Pellet Mill Fixed Dies Type for Production of Solid Fuel Pellets from Acacia mangium Bark. In IOP Conference Series: Materials Science and Engineering (Vol. 557, No. 1, p. 012057). IOP Publishing.

[7] El-Sheikha, A. M., Al-Rajhi, M. A., & Amer, H. A. (2020). Manufacture and Evaluation of an Alternative Feeds Production Machine. Journal of Soil Sciences and Agricultural Engineering, 11(12), 801-808.

[8] Onochie, U. P., Al, O., Aliu, S. A., & Ighodaro, O. O. (2017). Fabrication and Performance Evaluation of A Pelletizer for Oil Palm Residues and Other Biomass Waste Materials. Journal of the Nigerian Association of Mathematical Physics, 40, 443-446.

[9] Mancini, M., Mircoli, A., Potena, D., Diamantini, C., Duca, D., & Toscano, G. (2020). Prediction of pellet quality through machine learning techniques and near-infrared spectroscopy. Computers & Industrial Engineering, 147, 106566.

[10] Oduntan, O. B., Koya, O. A., & Faborode, M. O. (2014). Design, fabrication and testing of a cassava pelletizer. Research in Agricultural Engineering, 60(4), 148-154.
[11] Matúš, M., Križan, P., Šooš, Ľ., & Veteška, V. (2021). Design of pressing tools for pelleting machines.