SITEKIN: Jurnal Sains, Teknologi dan Industri, Vol. 21, No. 1, Desember 2023, pp.19 - 27
ISSN 2407-0939 print/ISSN 2721-2041 online

Design of a Manure Smelting Machine Using a 1 HP DC Electric Motor, Using a V-Belt

Galih Muji Tri Sutrisno[1*]
[1*]Progran Studi Teknik Mesin, Fakultas Sains dan Teknologi, Universitas Nahdlatul Ulama Sunan Giri
Jl. Ahmad Yani No.10, Jambean, Sukorejo, Kabupaten Bojonegoro, Jawa Timur 62115
Email: galinezha@yahoo.com

ABSTRACT

This plan is used to create working design drawings for the construction of a reliable, durable, safe, and effective livestock dung smelter machine, as well as to get the performance test results and economic analysis of the dung smelter. There are three different ways to phrase the issue in relation to the three planning goals. The design of a livestock manure crusher machine is done in stages, including task planning and explanation, product idea planning, and design. Technical examination examines torque, power generated by the shaft, and frame design. Due to the design of a manure smelter with SOP sizes of P 107 cm, L 27 cm, and H 124 cm, an electric motor with a power capacity of 900 to 1300 watts is intended to be used for the propulsion of the animal dung crushing machine. The machine must be able to produce 300 kg per hour of driving source DC electric motor, which is equivalent to 1 horsepower. engines' power The transmission system, which uses a V-belt and a driving shaft with a diameter of 3 cm, is what powers the engine. The 2.0 mm thick plate used in the frame construction rotates at 1400 RPM and is formed of 6 mm canal iron and tubes.

Keywords: *design, electric motors, manure, materials, smelting machines*

Introduction

Indonesia as an agricultural country where most of the population works in agriculture where the success of the farmers will support food security in Indonesia [1]. Agriculture in Indonesia in this case plays a very important role in helping the government to meet food needs for the entire population in Indonesia. Food in Indonesia includes commodities such as rice, corn, soybeans and others [2]. Rice as a producer of rice is one type of food plant which is the staple food for Indonesian people. Based on data from the Central Statistics Agency, household consumption of rice is 20,685,619 tons or around 77.5 kg per capita per year. So that it can be said that rice is still the most important staple food for the people of Indonesia, this condition is of course the main staple food for the government to continue to strive to meet national food needs.

Adequacy of national food needs can be considered as a condition of national food security, but there are several problems in the agricultural sector, especially in terms of fertilizer supply. Fertilizer is a major problem in agriculture, due to farmers' dependence on chemical fertilizers. The continuous use of chemical fertilizers can damage soil conditions, causing the soil to harden and lose its porosity. Meanwhile, using non-subsidized chemical fertilizers is too expensive, not comparable to the yields obtained. The development of technology in agriculture has made Indonesian farmers begin to learn to know manufacture and use of fertilizers using organic materials. Sources of organic materials can be in the form of green manure, compost and manure. One type of organic fertilizer that can be developed or made by farmers easily is fertilizer that utilizes kohe goat manure as an alternative substitute for chemical fertilizers [3], [4].

This is supported by the availability of livestock manure in Indonesia. Goat livestock is one of the livestock that is in great demand by people in Indonesia, especially people in villages. Adult goats are capable of producing as much as 0.5 kg of excrement per day, which can become a problem in the long term if not handled properly. There are various ways to deal with goat manure, one of which is to use the waste as manure which can benefit farmers to supply nutrients for plants and improve the physical and chemical properties of the soil [5], [6]. Goat manure is an organic waste that comes from the rest of the digestive process of goat food, this goat manure is different from cow manure or other animals, goat manure has a hard texture so that if it is used as plant fertilizer by sprinkling it directly, the results are less effective and It takes a long time for the manure to decompose[7], [8].

Goat manure has a hard skin geometry. However, this waste can be utilized as an effective fertilizer for soil and plants [9]. Based on the urgency of the importance of processing goat dung waste that can be used as fertilizer for soil and plants. Thus a goat manure processing tool is needed, namely a goat manure grinding

machine, The implication of the benefits of the design of a goat manure grinding machine is to crush the hard skin geometry so that the application to soil and plants is more effective [10]. The need for goat manure crushing machines/equipments is currently one of the appropriate tools or technologies that are urgently needed in the animal husbandry and agriculture fields, in the processing of livestock manure into powder as alternative manure [11]. This crushing tool itself is a development of agricultural tools that cannot be separated from the development of science and technology, one of which is in the field of engineering [12]–[14]. Scientific technology in the field of engineering in the design of goat manure crushing equipment includes processing technology, supporting tools and the use of supporting materials in agriculture[15]. Appropriate technology in the manufacture of crushers that are applied to dry goat manure/kohe [16], [17]. This study aims to design an animal manure melting machine that uses a 1 HP DC electric motor drive using a V-Belt. Animal manure is an organic waste that often requires special handling to avoid environmental pollution. In this study, the design of a melting machine that can convert animal waste into safer materials and can be used as organic fertilizer by farmers, taking into account low cost, simple and not many tool components so that it can support the productivity of farmers in processing waste into fertilizer [18]–[22].

Research Methods

Product concept design

The goal of product concept design is to produce as many alternative product concepts as possible. The concept of the product to be produced on a schematic or in the form of a sketch (sketelons). Basically all the design concepts for a product meet the specifications required in the product engineering phase. In designing the final concept of a product, it is necessary to evaluate the results of the product concept design for one of the best products to be developed and innovated in the third phase, namely the product design phase or the phase of giving shape to product design.

Product design consists of several concept steps, but in essence there are phases of alternative solutions in the form of schemes or sketches which are further developed to produce a product or technical object whose shape, material and dimensions are determined. If there is more than one alternative solution, a better final solution must also be determined through a better solution evaluation process. The best opinion is expressed in the form of a general arrangement drawing.

Drawing phases and product manufacturing specifications

Component arrangement drawings, product arrangement drawings and specifications containing information that cannot be contained in a drawing

Results and Discussion

Making Labor Estimates

Make estimates of labor and time needed to achieve goals

Table 1. Estimated manpower and time required

Work	Power	Time
Design simple elements and components to modify from existing products	One designer	One week
Make technical specifications	One designer	One week
Create a product concept I	One designer	One week
Create a product concept III	One designer	One week
Create a product concept III	One designer	One week
Create a product concept IV	One designer	One week
Create a product concept V	One designer	One week
Determine the best concept by using a decision-making matrix	One designer	One week
Calculation of machine elements	One designer	One week
Create design drawings using Autocad	One designer	One week
Product manufacture	One designer	One week

Create A Function Block Diagram

In a livestock manure crusher that will be designed for this task, the input energy uses electrical energy which is then in the smelting machine the livestock manure is transformed to a shaft with a v-belt transmission so that it is able to move the knife inside the tube to crush animal manure in one process times.

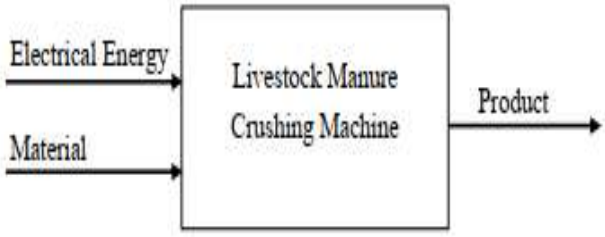

Figure 1. Block the function of a livestock manure crusher machine

Tool Design Block Diagram

In this livestock manure melting machine there is one energy input with an electric motor source which is transmitted by the pulley and v-belt which is then continued to the shaft so that the livestock manure is melted in the tube, so that the animal manure is smooth and evenly distributed with maximum.

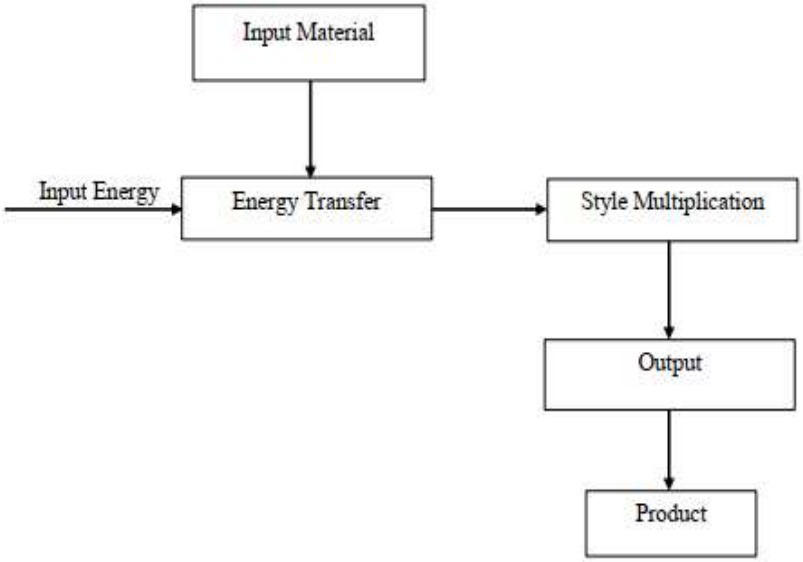

Figure 2. A block diagram of a livestock manure smelting machine

Tabel 2. Morphology matrix of livestock manure smelting machines

Matrix parameters		
Install	With Hand	One Hand A.1
		Two Hands A.2
	With Tools	Shovel B.1
		Pouch B.2
Activate 2		
		C.1 Switch
Energize	Connect	On/Off Button C.2
		Manual D.1
	Activate	Automatic D.2
Change Energy	Electricity	Dc Motor E.1
		Diesel Engine E.2
	Mechanic	Gear F. 1
		F.2 Rotating Axle
Style Multiplication 3		
		Pulleys G.1
		V-belt G.2
Energize	Transmission	Spokes G. 3
		G.4 Chain

From the morphological matrix above, several product alternative sketches can be made which can later be considered for further processing. Here are some product sketches that have been made:

1) Concept I :

A.1+B.1+C.1+D.1+E.2+F.2+G.3+G.4

2) Concept II :
A.2+B.1+C.2+D.2+E.2+F.1+G.3+G.4
3) Concept III :
A.2+B.2+C.1+D.2+E.1+F.2+G.1+G.2
4) Concept IV :
A.1+B.2+C.1+D.1+E.2+F.1+G.3+G.4
5) Concept V :
A.1+B.1+C.2+D.2+E.1+F.2+G.1+G.2

Create a Product Concept Sketch

Concept 1

In concept 1, the animal manure melting machine then inserts the manure-making material using only one hand, how to put it in using a shovel. Then, to turn on, it is enough to turn on the switch button, the electric motor will turn on, rotate the sprocket that connects the chain to rotate the player shaft and on the right and left sides there is a knife that can adjust the level of smoothness of a product.

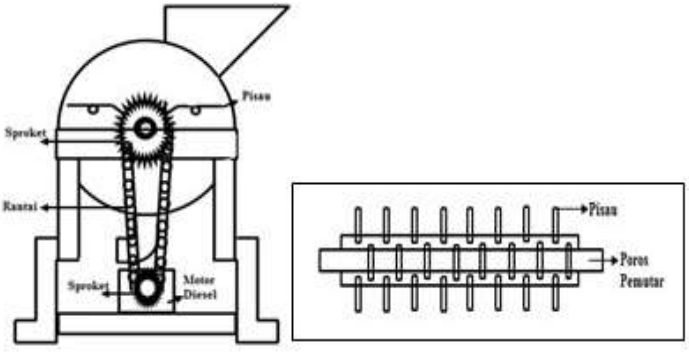

Figure 3. Concept 1

Concept 2

In this concept, animal dung smelting machines, in order to smelt, need to use two hands and use a shovel. To start the machine is done by pressing the ON / OFF button, the DC motor will automatically turn on to rotate the sprocket connected to the chain so that the player shaft will rotate and the blades will crush the dirt.

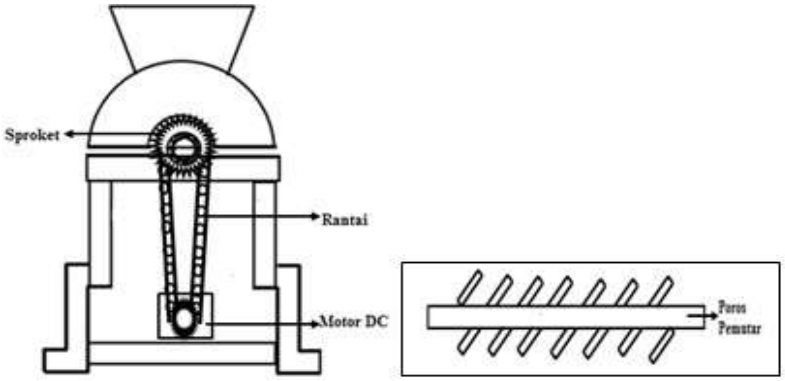

Figure 4. Concept 2

Concept 3

In concept 3, the manure smelter machine uses 2 hands to put it in a bag. To turn on the dung smelter machine, the switch is used to automatically turn on the DC motor. The rotation of the DC motor is continued using a V-Belt to rotate the player shaft and the right side. to the left lies a knife that can adjust the level of fineness of the product.

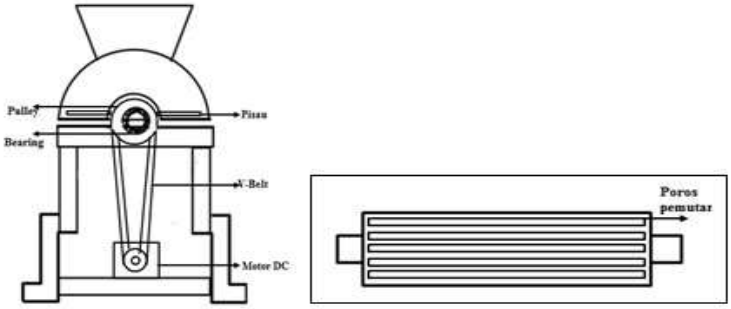

Figure 5. Concept 3

Concept 4

In this concept, the manure smelter requires 1 hand to put the dirt into the bag to destroy it. Then turn on the smelter using a switch to start the electric motor manually. The rotation of the electric motor is continued by the spoket and then connected to the gear to rotate the dirt melting knife.

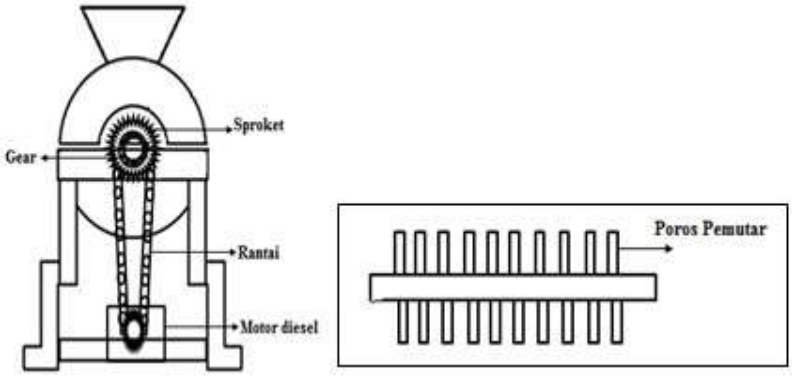

Figure 6. Concept 4

Concept 5

In this concept, this manure melting machine requires one hand to put in the dirt to be melted. Then to turn on this machine use the Switch ON / OFF button which functions as a source of propulsion. The rotation of the electric motor will be continued through the pulley which is then connected by a V-Belt to rotate the player shaft and on the right and left there is a knife that can adjust the level of smoothness of a product.

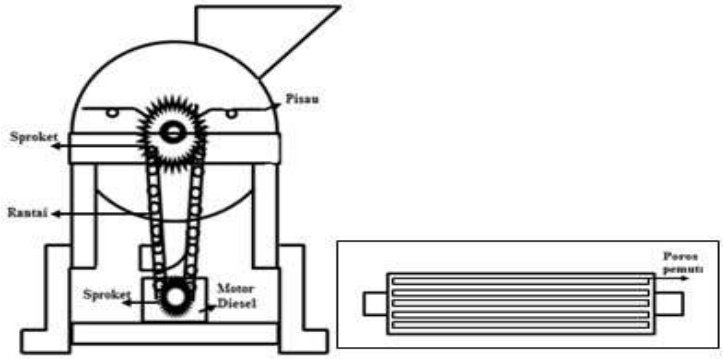

Figure 7. Concept 5

Table 3. Product concept assessment

Num.	Selection Criteria	Weight	Concept 1	(Ref)	2	3	4	5
1	Strong and durable	10	7		6	9	8	5
2	Not many components	9	9	R	8	8	8	6
3	Big production	8	8	E	7	7	7	8

4	Manufacturing costs	10	6	F	5	10	6	7
5	Light	7	5	E	6	7	8	6
6	Easy operation	9	6	R	7	8	6	9
7	Easy maintenance	8	5	E	7	8	7	6
8	Energy transfer	8	5	N	6	7	6	7
9	Likely to be massed	7	5	C	6	7	6	8
10	Operation safety	7	6	E	6	7	5	5
11	Reliability	9	9		9	8	8	9
Amount Overall Weight Value			71		73	86	75	76

Giving Shape To The Selected Concept

After designing the product concept, the next step is product design. And the product concept which is still in the form of a sketch is given a shape, therefore it is also referred to as product giving. From selecting a product concept, you need to choose a concept which will then be given a shape into the manufacture of a livestock manure smelting machine product. The following shows the design of the product to be developed, with the design using AutoCad software.

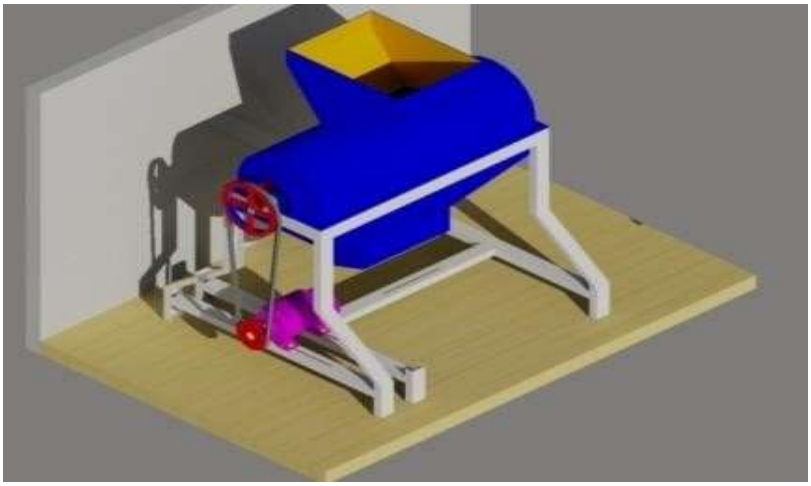

Figure 8. Overall model of a livestock manure smelting machine

The following shows a model of the components of the livestock manure smelting machine product:

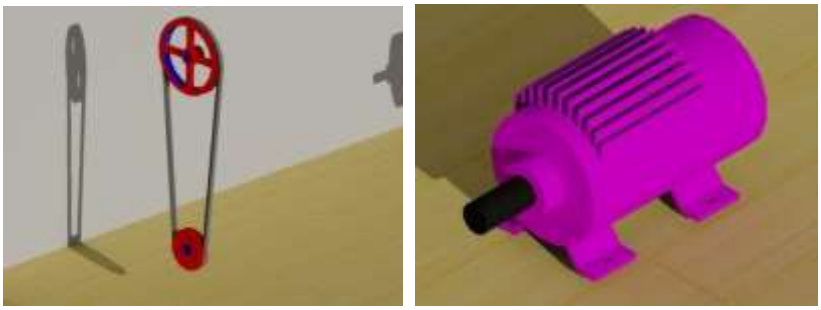

Figure 9. Pulley and v-belt (b) electric motor

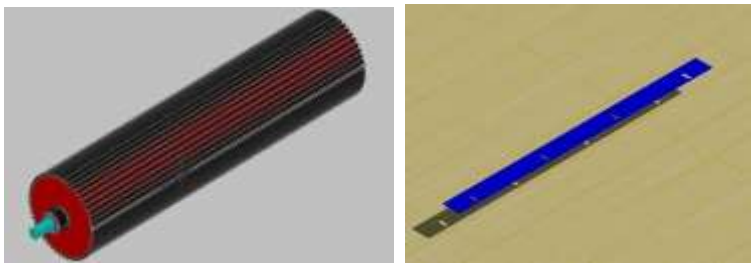

Figure 10. Rotating shaft and narrowing knife

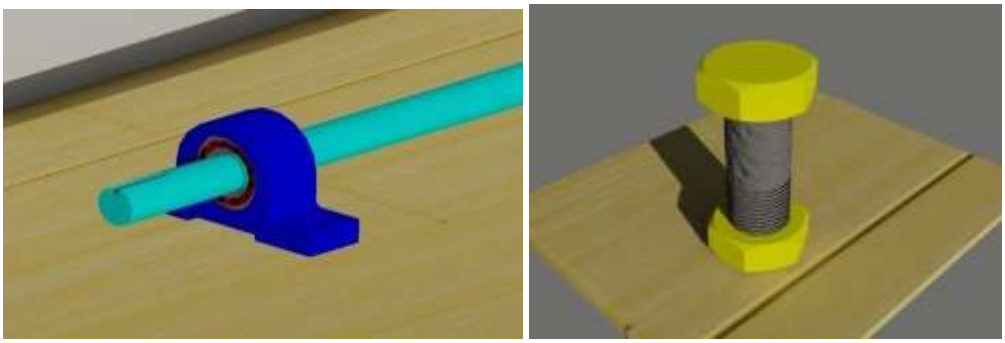

Figure 11. Bearings and nuts bolts

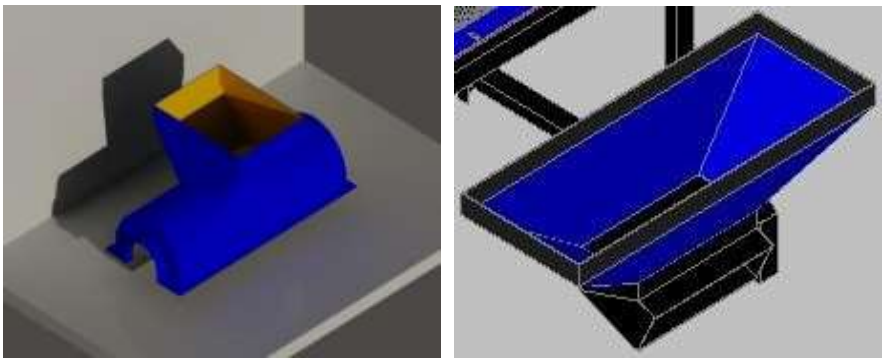

Figure 12. Input and output

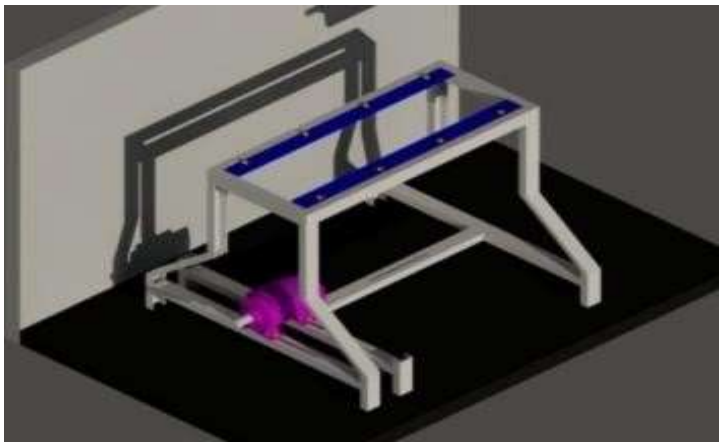

Figure 13. Framework

Capacity Analysis A production

To calculate the production capacity, it is necessary to carry out a trial run using a cow manure crusher to convert it into fertilizer. In this calculation analysis, an example of an experiment to calculate the production capacity of 25 kg of animal manure is obtained, the following data is obtained:

Table 4. Cow manure experimental data

Num.	Mass of Cow Dung	Time (Minutes)
1	5 kilogram	37 seconds (0.37)
2	10 kilogram	1 minute 14 seconds (1.14)
3	15 kilogram	1 minute 51 seconds (1.51)
	Amount	3 minutes 42 seconds (3.42)

The average crushing time is 10 kilograms of cow dung:

$= \frac{(0{,}37+1{,}14+1{,}51)}{3} = 2\ minutes$

Crushing capacity:

$= \frac{average\ cow\ manure}{average\ crushing\ time} = \frac{10\ kilogram}{2\ minutes} = 5\ kilogram/minutes$

Table 5. Advantages and disadvantages of livestock manure crusher machine

Num.	Excess	Lack
1	Manufacturing costs are not expensive	The weight of the machine is considered too heavy
2	Simple mechanism	Setting the fineness of animal manure is still difficult
3	Machine components not much	If there is a power outage the machine cannot be operated

Conclusion

From the results of the design and calculations on the design of a livestock manure crusher machine, a machine design with dimensions of 124 cm in height, 76 in width, 107 cm in length and a machine weight of ± 80 kg is obtained. This machine has not too many components, such as 1 crusher body, 1 shaft which functions to drop animal manure, a knife placed in the middle of the body which can adjust the fineness level of 2 livestock manure, v-belts and pulley with a total of 1 piece. The results of production capacity testing show an average time of 2 minutes required to crush 10 kg of manure, with a crushing capacity of 5kg/minute. Based on the results of the design, calculation and testing of this animal manure crushing machine design, it can be concluded that this machine can be an alternative solution for farmers in processing manure waste into fertilizer, with low cost, simple and not too many tool component requirements. Suggestions for further research are to continue to the implementation stage and to analyze engine performance in terms of energy efficiency, crushing speed and power consumption.

References

[1] Dewan Ketahanan Pangan, "Kebijakan Umum Ketahanan Pangan 2006 – 2009," *Gizi dan Pangan*, vol. 1, no. 1, pp. 57–63, 2009.

[2] A. Mulyaningsih, A. V. S. Hubeis, and D. Sadono, "Partisipasi petani pada usahatani padi, jagung, dan kedelai perspektif gender," *J. Penyul.*, vol. 14, no. 1, pp. 145–158, 2018, doi: 10.25015/penyuluhan.v14i1.18546.

[3] D. K. Anwar, M. F. R. P, H. Kifli, I. M. Ridha, P. P. Lestari, and H. Wulandari, "Kombinasi Limbah Pertanian dan Peternakan sebagai Alternatif Pembuatan Pupuk Organik Cair Melalui Proses Fermentasi Anaerob," *Pros. Semin. Nas. Teknoin 2008 Bid. Tek. Kim.*, pp. 95–100, 2008.

[4] B. Sharma, B. Vaish, Monika, U. K. Singh, P. Singh, and R. P. Singh, "Recycling of organic wastes in agriculture: an environmental perspective," *Int. J. Environ. Res.*, vol. 13, pp. 409–429, 2019.

[5] Erni Suryani, "Pemanfaatan Kompos Organik Terhadap Pertumbuhan Tanaman Jagung Dan Sifat Fisik Tanah," *JUSTER J. Sains dan Terap.*, vol. 1, no. 1, pp. 44–48, 2022, doi: 10.55784/juster.vol1.iss1.17.

[6] J. F. Nipa, M. H. T. Mondal, and M. A. Islam, "Design, development and performance evaluation of small-scale fodder chopping machine for farmers," *Res. Agric. Eng.*, vol. 67, no. 3, pp. 116–122, 2021.

[7] N. I. Mansyur, E. H. Pudjiwati, and A. Murtilaksono, *Pupuk dan pemupukan*. Syiah Kuala University Press, 2021.

[8] M. Handajaningsih, "Compost derived from local organic materials as source of plant nutrients," in *IOP Conference Series: Earth and Environmental Science*, 2018, vol. 215, no. 1, p. 12030.

[9] N. L. Nurida, A. Dariah, and S. Sutono, "Pembenah Tanah Alternatif untuk Meningkatkan Produktivitas Tanah dan Tanaman Kedelai di Lahan Kering Masam," *Pembenah Tanah Altern. untuk Meningkat. Produkt. Tanah dan Tanam. Kedelai di Lahan Kering Masam*, vol. 39, no. 2, pp. 99–108, 2015.

[10] K. Nadliroh, "Rancang Bangun Mesin Penggiling Kotoran Kambing dengan Sudu Berbentuk Martil," *J. Mesin Nusant.*, vol. 2, no. 1, pp. 18–26, 2019, doi: 10.29407/jmn.v2i1.13345.

[11] S. Andjar Sari, P. Vitasari, and S. L. A., "Pengembangan Desain Mesin Penghancur Kotoran Kambing Dengan Menggunakan Metode QFD," *J. Teknol. Dan Manaj. Ind.*, vol. 4, no. 2, pp. 29–34, 2018, doi: 10.36040/jtmi.v4i2.243.

[12] I. Sodikin, J. Waluyo, and Y. Pratiwi, "Rancang bangun tungku pemanas untuk pande besi yang ramah lingkungan guna meningkatkan kapasitas produksi alat pertanian," *Simp. Nas. ke 15 RAPI*, pp. 458–463, 2016.

[13] P. C. Okolie, I. C. Chukwujike, J. L. Chukwuneke, and J. E. Dara, "Design and production of a fish feed pelletizing machine," *Heliyon*, vol. 5, no. 6, p. e02001, 2019.

[14] E. K. Mindarta, A. A. Wibowo, and A. B. N. R. Putra, "Designing portable chopping plastic waste machine utilizing electric motor," in *MATEC Web of Conferences*, 2018, vol. 204, p. 4005.

[15] V. A. Wardhany, A. Hidayat, and A. Afandi, "Smart chopper and monitoring system for composting garbage," in *2019 2nd International Conference of Computer and Informatics Engineering (IC2IE)*, 2019, pp. 74–78.

[16] Mukono., "Toksikologi Lingkungan. Surabaya: Airlangga University Press.," vol. 6, no. 3, 2005.

[17] R. Bulan, R. Rahmah, A. R. Hasan, and A. Sitorus, "Design and construction of oil palm fronds (OPF) compost mixer machine type rotary double helix drum," in *2019 5th International Conference on Computing Engineering and Design (ICCED)*, 2019, pp. 1–4.

[18] I. N. Permadi and D. B. Nisa, "A Model Experiment Design Using the Taguchi Method: A Case Study Of Making Concrete Roof," *J. Ris. Ilmu Tek.*, vol. 1, no. 1, pp. 36–44, 2023.

[19] G. Filhaq, S. Aprianto, and H. Alfianto, "Design of Smart Locker Door Using Quality Function Deployment Based on ATMega 2560 Microcontroller," *J. Ris. Ilmu Tek.*, vol. 1, no. 1, pp. 25–35, 2023.

[20] F. Pohan, I. Saputra, and R. Tua, "Scheduling Preventive Maintenance to Determine Maintenance Actions on Screw Press Machine," *J. Ris. Ilmu Tek.*, vol. 1, no. 1, pp. 1–12, 2023.

[21] V. C. Dewi, V. Amrizal, and F. E. M. Agustin, "Implementation of Adaptive Neuro-Fuzzy Inference System and Image Processing for Design Applications Paper Age Prediction," *J. Ris. Ilmu Tek.*, vol. 1, no. 1, pp. 45–57, 2023.

[22] T. M. Sari and W. Dini, "Risk Assessment and Mitigation Strategy in The Halal Broiler Supply Chain," *J. Ris. Ilmu Tek.*, vol. 1, no. 1, pp. 13–24, 2023.