OPTIMIZATION OF SIFTING CAPACITY OF AN IMPROVED DEWATERED CASSAVA MASH SIFTING MACHINE USING DESIGN OF EXPERIMENT

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ABSTRACT
The aim of this study was to optimize the sifting capacity of an enhanced dewatered cassava mash sifting machine through experiment design and application. The goal is to determine the best performance indicators between the response variable (sifting capacity) and the operational variables (cassava mash mass and operating time). General full factorial design (GFFD) is used in experiment design to accomplish this. Nine treatments with three replicates were included in the design, for a total of twenty-seven treatments. The mass of cassava mash, operating time, and sifting capacity were among the experimental test parameters that were established. The experiment was carried out at the Nigerian Stored Product Research Institute's postharvest engineering research department, located in the Port Harcourt Zonal Office in Nigeria. Statistical analyses, including analysis of variance (ANOVA), main and interaction effects, multiple linear regression model, and response optimization using MINITAB 21 software were used. Also, the validity of the model was checked using standard error (SE), coefficient of determination (r^2), Adjusted $\mathbf{r^2}$, and prediction $\mathbf{r^2}$. The results revealed that the application of cassava mash mass and time of operation have the highest scapacity at 90 kg and 0.6 hr using the machine. According to ANOVA, sifting capacity was significantly impacted ($P<0.05$) by cassava mash mass and time of operation. The sifting capacity multiple regression model was created with coefficients determined in the models. The models' above 95% prediction accuracy was substantiated. At a cassava mash mass of 90 kg and a time of operation of 0.6 hr, the optimal sifting capacity during sifting was attained.

Keywords: Cassava mash, general full factorial design, optimization, sifting machine, sifting capacity

1 INTRODUCTION
Cassava (*Manihot esculenta Crantz*) is widely recognized across globe, especially in the developing countries as a source of carbohydrates, calories, vitamin C, thiamine, riboflavin, niacin and several other nutrients that are essential to human (FAO, 1997; Montagnac et al., 2009). In Africa, Nigeria is the largest producer of cassava (Amerije, 2016) which can be processed into several foods and delicacies and any or all its components are either found very useful for human or livestock consumption (Alonge *et al.,* 2012).

Gari is the major products from the numerous products of cassava and it is seen to be the most utilized product (Amerije, 2016). There are several processing steps involved in processing cassava tubers into garri, include peeling, washing, grating, pressing, shifting, frying. The stability of gari when it is finally transformed into the gelatinized form is influenced by each of these processing steps (Oni *et al.*, 2009). Gari sifting reduces the labor-intensive process and drudgery involved in manual sieving, and it ultimately contributes to a better and more consistent final product. Gari processing has been the subject of numerous studies, with small and medium-sized processing receiving the majority of the focus. A cassava lump breaker was constructed by Sulaiman and Adigun (2008), but a thorough performance assessment of the machine's efficiency and throughput capacity was not done. Alabi (2009) developed a motorized cassava lump breaker and sifter. It was suggested for the operator's safety, that an outlet be included for materials that weren't sorted, include the hopper, pulley and electric motor be covered. An electric motor-powered motorized cassava mash sifter was developed and evaluated by Kudabo et al. (2012). A motorized dewatered cassava mash sifter was created and assessed by Jackson and Oladipo (2013) in order to ascertain how operation speed affected the sifting effectiveness of the device. All of the designs discussed were quiet on the sieve aperture sizes that were utilized to generate the speeds, outputs, and efficiencies (Ahiakwo et al., 2015).

Ahiakwo et al. (2015) evaluated the current state of sieving technology and projected the development of an efficient sieving technology. A motorized garri sieving machine was developed and tested by Ovat and Odey (2018). It included new features like a lump breaking pot, an aluminum sieving chamber to stop corrosion and rust, guards on moving parts to protect the operator and extend machine life, and links in place of cams and followers. The designs by Ovat and Dey (2018) were batch flow oriented, which always has an impact on large-scale manufacturing. An enhanced gari mash sifter was developed and assessed by Ajanwachuku et al. (2021). They stated that the development of this machine has reduced the risks and drudgery involved in the widely used human sifting method while also improving the timeliness of the garri sifting process. As a result, a reciprocating sieve that is intended for high capacity and operational efficiency must be used to optimize an enhanced continuous flow type dewatered cassava mash sifter.

Sifting the dewatered mash is an essential step in cassava processing that produces homogeneous granules that improve drying effectiveness and the quality of the finished product (Akinoso et al., 2018). Conventional sifting techniques frequently result in irregular particle sizes, labor-intensive processes, and time commitments, which lower processing efficiency and product standards.

Throughput and quality of cassava-based products can be greatly increased by optimizing the design and functionality of sifting machines. To cut down on labor expenses and processing time, automated systems have been integrated into machines in recent years (Omodara et al., 2020). The ideal operating parameters that affect the sifting capacity, such as feed rate, tilt angle, sieve mesh size, and vibration frequency, are still not well understood. The outcome is expected to offer a scientific basis for parameter selection and operational guidelines for enhanced cassava processing. Ajanwachuku and Ekemube (2025) optimized the throughput capacity of cassava dewatered mash sifting machine using general full factorial design in design of experiment. They reported that the optimal desirability of the machine was obtained at cassava mash mass of 90 kg and a time of operation of 0.6 hr. Another statistical metric to confirm the accuracy of the optimization plot is the composite desirability (D) (Ciopec *et al.*, 2012). According to Chang *et al.* (2015), when the composite desirability (D) is near 1.00, the optimization of factors and answers derived from the statistical analysis is extremely precise and dependable.

The efficiency of cassava mash sifting remains a critical bottleneck in small- to medium-scale cassava processing enterprises. Manual sifting techniques are inefficient, leading to low throughput and variability in mash granularity. Although mechanized sifting machines have been developed, they are often operated at suboptimal conditions due to lack of empirical performance data. Consequently, there is a need to determine the optimal combination of machine parameters that significantly enhance sifting capacity and efficiency. Moreover, the absence of a standardized approach to evaluate and optimize the performance of such machines has hindered their widespread adoption. Without proper optimization, machine operations may consume excessive energy or yield poor-quality output. This study leverages the power of Design of Experiment to identify, model, and optimize key factors affecting the performance of an improved cassava mash sifting machine.

Hence, this study is aimed at establishing optimum performance indicators between operation variables (cassava mash mass, and time of operation) and their effect on sifting capacity using general full factorial design in design of experiment, thereby improving the quality of sieving and productivity.

2 MATERIALS AND METHODS

2.1 Description of the Machine

The improved motorized dewatered cassava mash sifting machine consists of the following components as shown in Plates 1 to 5. The main unit of the machine on which all other components of the machine are supported is the main frame. The hopper is a trapezoidal shaped pyramid through which lumps of dewatered mash cake are fed into the sieving trough through gravity. Sieving chamber is a rectangular trough of considerable depth to prevent spilling of agitated particles during operation and length to ensure that the product coming out at the discharge end of the sieve would be chaff alone, that is sieving would have been completed by the time the products get to the discharge end. The pulley and belts are preferred to this purpose as the distance between the two pulley is short, resulting in negligible slip between pulleys, easy installation, long life, high velocity ratio, high power transmission and its ability to absorb shock. Also, a discharge outlet that consists of the outlet chute for the fines (under-sized particles). Electric motor: this provides the power needed to operate or run the machine. Bearings is used to provide support for the shaft and reduce friction between moving parts which can cause a loss of available power. Camshaft is used to transmit power from one place to another.

Basically, power generated by the 1-hp electric motor is delivered to the camshaft a device which converts rotational motion to reciprocating motion. The motion generated because of the rotation of the camshaft in the pulley and belt arrangement is further transmitted to the sieve housing thus providing the forward throw while the spring positioned in the opposite direction returns the sieve on the backward throw. This to and fro linear movement (reciprocating action) of the sieve housing leads to the sifting action of the pulverized garri mash.

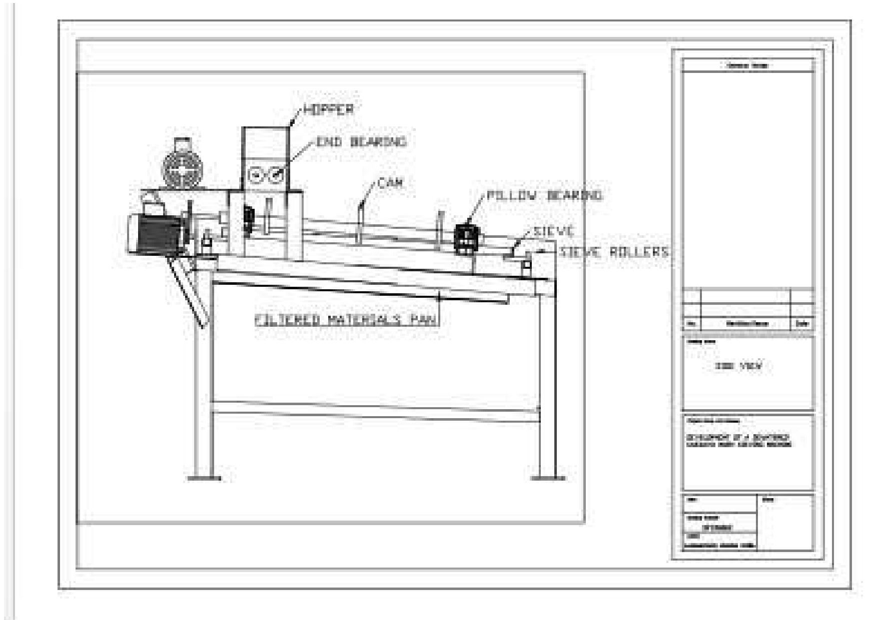

Plate 1. Side View Elevation of Dewatered Cassava Mash Sifting Machine

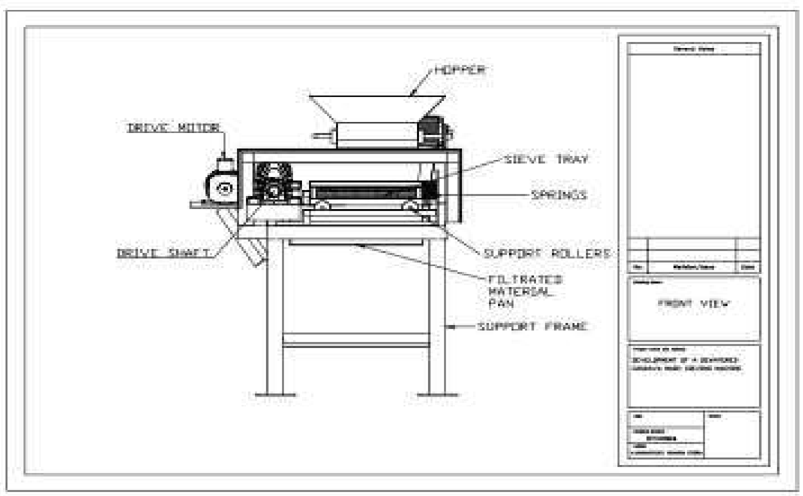

Plate 2. Front View Elevation of the Machine

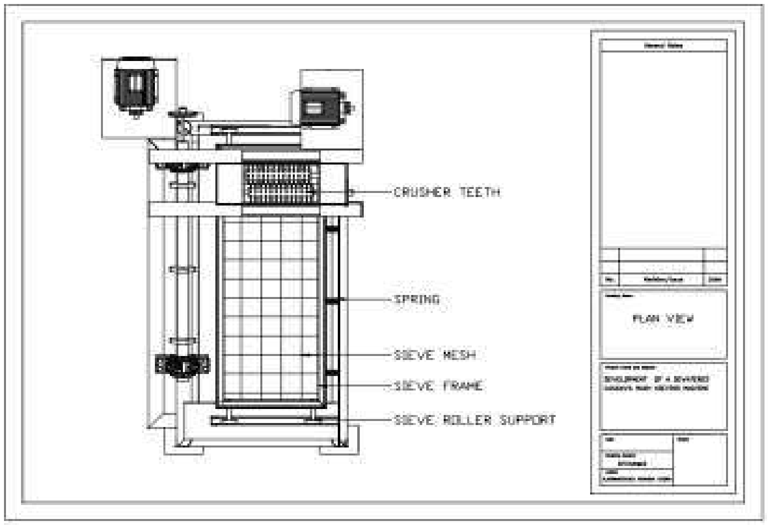

Plate 3. Plan View of Dewatered Cassava Mash Sifting Machine

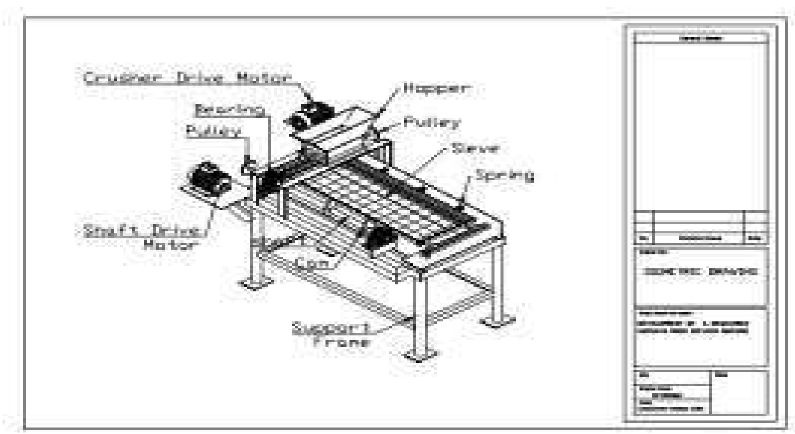

Plate 4. Isometric Drawing of Dewatered Cassava Mash Sifting

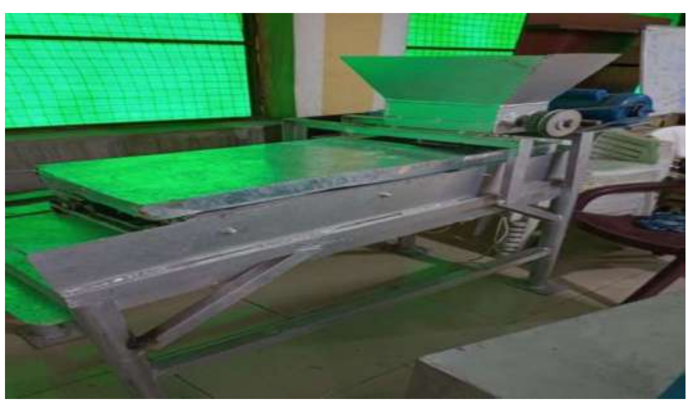

Plate 5. Fabricated Motorised Dewatered Cassava Mash Sifting Machine

2.2 Experimental Procedure and Performance Evaluation

The machine was tested at an operational speed of 1725 rpm using 1hp single phase electric motor at 30, 60, and 90 kg loadingively. The different masses of dewatered cassava mash were weighed on a weighing scale and recorded. Each mass of cassava mash beginning with 30 kg was then fed into the hopper, which in turn was properly spread out into the sieving chamber. The machine was running until the cassava mash was completely sieved. The mass of cassava mash sieved and the time taken to complete each sieving operation were recorded. The procedure was repeated three times with respect to each weight and their averages. At the end of operation, the machine capacity was determined using Equation 1.

The machine sifting capacity: This is the rate at which the machine sieves in kilogram per hour (kg/hr). This was determined using the relation:

$$Sc = \frac{Mm}{t} \tag{1}$$

where,

Sc = Sifting capacity (kg/hr)
Mm = Mass of cassava mash loaded into sieve (kg)
t = Time taken to complete the sifting (hr)

2.3 Experimental Design

The design of experiment (DOE) adopted in this study is general full factorial design (GFFD) that was carried out using MINTAB 21 program. A 3^2 full factorial design (two factors at three levels with replicates) was used to examine the effects of two parameters on the garri mash shifter during the sieving of dewatered cassava mash. This design is based on the one response factor and two operational factors as described by Ekemube *et al.* (2023a, 2023b; 2024); Ajanwachuku and Ekemube (2025). The variables cassava mash mass and time of operation) and their levels of operation (mass in kg nad time in hr) were selected. The dewatered cassava mash mass (30, 60, and 90 kg) and the time of operation (0.2, 0.4, and 0.6 hr) were the two variables. The response analyzed was sifting capacity (Tc). Based on the reponse variables, the sifting of dewatered cassava mash was separated into three blocks: block 1 was for 30 kg, block 2 was for 60 kg, and block 3 was for 90 kg. Nine experimental treatments with three duplicates were included in the design. In this study, randomization was carried out using the MINITAB 21 program (Minitab Inc, State College, PA, USA).

2.4 Statistical Analysis

The experimental data collected were simulated into the MINITAB software that was used to perform statistical analyses College, PA, USA). The plot of interaaction, and response optimizer were also carried out. A two-way ANOVA was caried out to establish statistical differences between the treatment. Differences were deemed significant at a 95% confidence level ($p < 0.05$).

2.5 Prediction Equation

The cassava mash mass and time of operation are the input variables and sifting capacity is the response variable that were used for the development of the prediction equation. The multiple linear regression model describing the sifting capacity during machine operations were expressed in Equations 2. This Equation 2 was generate with MINITAB by simulating the experimental results into the software.

$$S_c = \alpha + \beta_1 Mm_1 + \beta_2 Mm_2 + \beta_3 Mm_3 + \beta_4 T_1 + \beta_5 T_2 + \beta_6 T_3 + \beta_{11} Mm_1 T_1 + \beta_{12} Mm_1 T + \beta_{13} Mm_1 T_3 + \beta_{21} Mm_2 T_1 + \beta_{22} Mm_2 T_2 + \beta_{23} Mm_2 T_3 + \beta_{31} Mm T_1 + \beta_{32} Mm_2 T_2 + \beta_{33} Mm_3 T_3 \quad (2)$$

where,

S_c = Sifting capacity, kg/hr,

α = Intercept (Average value of the result),

β_1, β_2, β_3, β_4, β_5, β_{11}, β_{12}, β_{13}, β_{21}, β_{22}, β_{23}, β_{31}, β_{32}, and β_{33}, = Interactions' coefficients,

$Mm_{12,3}$ = Cassava mash mass, kg

$T_{1,2,3}$ = Time of operation, hr

2.5.1 Validation of the multiple linear regression model

The model was validated by simulating the experimental data into model. The results of the simulated experimental data (i.e., predicted data) were used to compare the experimental and predicted data using standard error, the developed multiple linear regression models were validated (Ekemube *et al.*, 2023a, 2023b; 2024, Ajanwachuku and Ekemube, 2025).

2.5.2 Evaluation of model prediction ability

To determine whether the measured and predicted results have a good agreement to assess their validity, the 95% confidence interval and prediction interval, coefficient of determination (r^2), adjusted r^2 (Adj r^2), and predicted r^2 [r^2 (Pred)] were employed. Minitab-21 software (Minitab Inc., State College, PA, USA) was used (Ekemube *et al.,* 2023a, 2023b; 2024).

2.6 Optimization of the Quality

The response variable (sifting capacity) was optimized within the 95% confidence and prediction intervals using an optimization graph. The best appropriate maximum sifting capacity desired optimizer was reached with the best combination of operational conditions (cassava mash mass and operationg time). This was carried out using Minitab-21 for the optimization procedure (Minitab Inc., State College, PA, USA).

3 RESULTS AND DISCUSSION

3.1 Experimental Results

Figure 1 shows the shifting capacity of the dewatered cassava mash sifting machine (Table 1). The results were 10, 60, 110, 8, 57, 108, 12, 63, 113; 35, 110, 185, 33, 183, 38, 111, 187; 110, 260, 410, 107, 257, 407, 112, 262, 413 kg, for the combinations of cassava mash mass (30, 60 and 90 kg) and time of operation (0.2, 0.4, and 0.6 hr), respectively. The experimental results show that the increase in the levels of cassava mash mass (30, 60 and 90 kg) and time of operation (0.2, 0.4, and 0.6 hr), respectively, increased the throughput capacity. From Figure 1 and Table 1, that displayed the experimental results of this study. It showed that the maximum sifting capacity of utilizing this machine under study can be achieved by 90 kg of cassava mash and 0.6 hr time of operation.

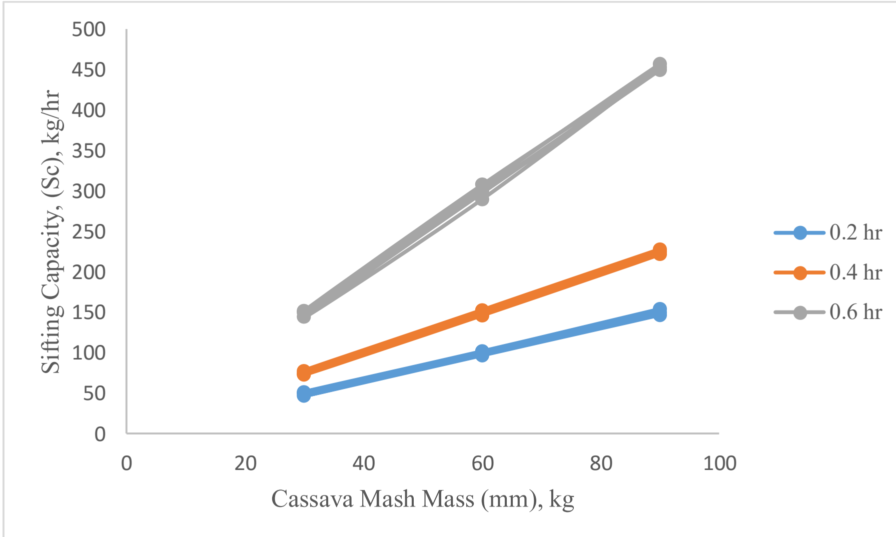

Figure 1. Plot of Sifting Capacity vs Cassava Mash Mass

Table 1. Experiment Results

Sifting Capacity, Sc (kg)	**Operation Time, T (hr)**		
	0.2	**0.4**	**0.6**
30	10	35	110
60	60	110	260
90	110	185	410
30	8	33	107
60	57	108	257
90	108	183	407
30	12	38	112
60	63	111	262
90	113	187	413

3.2 Main and Interaction Effects of Cassava Mash Mass and Time of Operation

The main interection plots is shown in Figures 2 and 3. The plots demonstrate the individual and combined effects of both main components (cassava mash mass and operation time) on the specific response (sifting capacity). By adding a center point to the design, it was possible to determine that there was a curvature between the levels. A decent sifting capacity can be achieved at the middle point of the factors. A maximum sifting capacity was achieved at 90 kg for cassava mass mass and 0.6 for time of operation as shown in Figure 2. The findings demonstrated that a significant sifting capacity is achieved during the operation of the machine by increasing mash mass and time of operation. The sifting capacity can be raised by raising the mash mass and time of operation, according to the interaction plots (Figure 3). On the other hand, the lines are not parallel to one another, according to the interaction plots. These suggested that the variables (mash mass and time of operation) interact. This is similar to the finding of Ajanwachuku and Ekemube (2025) that optimized throughput capacity of cassava sewatered mash sifting machine.

The ANOVA results is presented in Table 2 that was statistically used for comparison on the main effects of cassava mash mass and time of operation on cassava mash mass. This revealed that there was significant difference between the means at 95% significance level, since the calculated "F" value (401.83 and 443.21) is greater than the table "F" value (3.63 and 6.23, respectively). The interactions of Mm and T also had calculated "F" value (33.06) that is greater than table "F" value (3.63) which showed a significant different among the means at 95% significance level. In addition, it was found that the p-value for 'Mm' and 'T' linear factors and also 'Mm' interaction factor is 422.52 for the response (sifting capacity). Furthermore, it was found that the response (sifting capacity) had a p-value of zero for the "Mm" and "T" linear components as well as the "MmT" interaction factor. A factor is considered to have a more substantial impact on the response when the p-value is less than 0.05 (Prakash *et al*., 2008). ANOVA results based on the study indicated that the p-value (0.00) for both Mm and T factors is below the probability level ($P < 0.05$), and their combined values were also less than the probability level ($P > 0.05$). It can be infered that the sifting capacity generated by the machine was greatly impacted by the cassava mash mass (Mm) and time of operation (T) operational variables.

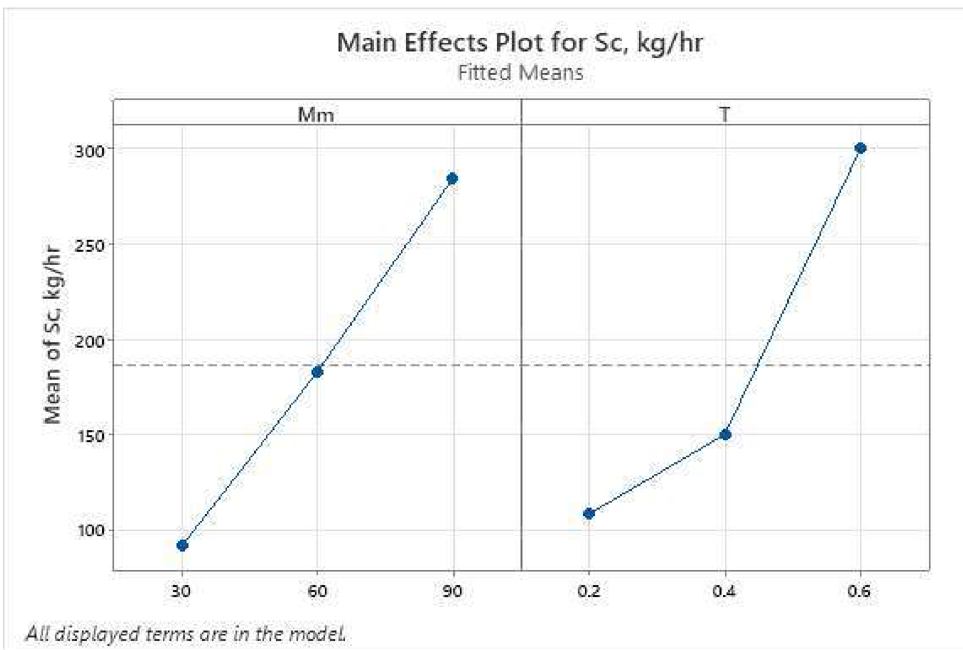

Figure 2. Plot of Main Effects (M_m and T) on S_c

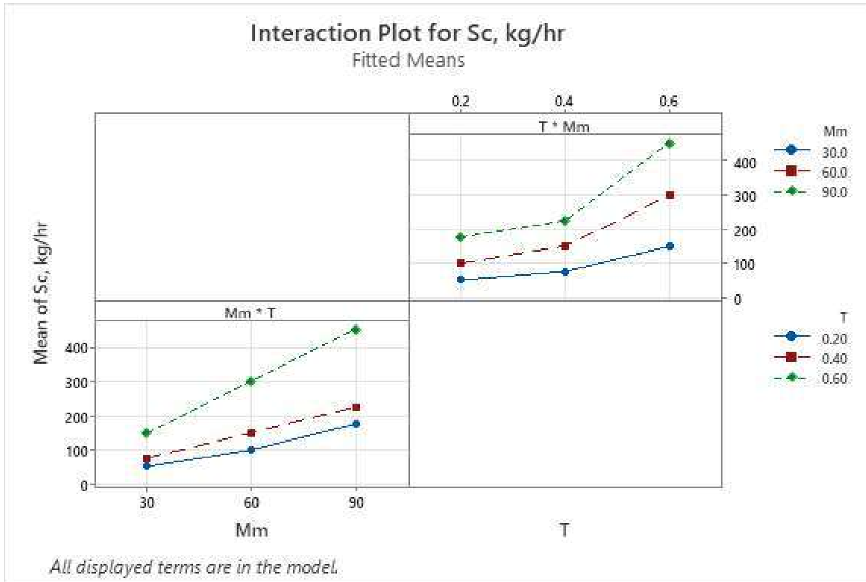

Figure 3. Plot of Interaction (Mm and T) on S_c

Table 2. Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Model	10	381335	99.10%	381335	38133.5	176.87	0.000
Blocks	2	569	0.15%	569	284.5	1.32	0.295
Linear	4	352373	91.58%	352373	88093.4	408.58	0.000
Mm	2	168160	43.70%	168160	84080.0	389.97	0.000
T	2	184213	47.87%	184213	92106.7	427.20	0.000
2-Way Interactions	4	28393	7.38%	28393	7098.3	32.92	0.000
Mm*T	4	28393	7.38%	28393	7098.3	32.92	0.000
Error	16	3450	0.90%	3450	215.6		
Total	26	384785	100.00%				

3.3 Prediction Equation

Table 3 shows the experimental and predicted data of sifting capacity of the machine. Table 4 presents the estimated coefficients for the regression analysis and multiple linear regression model for the sifting capacity of dewatered cassava mash sifting machine. The multiple linear regression model (Equation 3) revealed that the sifting capacity of the machine was significant, with a constant value of 186.26 and a SE of 2.83, along with a p-value of zero (0.000). However, component Mm (cassava mash mass) had coefficients with p-values less than 0.00, with the exception of 60 kg, while factor T (time of operation) had p-values of zero (0.00).. Accordingly, the precision level of the proposed regression model increases with the r^2 value's proximity to 100% (Al-Hassani *et al.*, 2014). In other words, the multiple linear regression model may be the most effective way to represent the measured data (Ekemube *et al*. 2023a, 2023b). The sifting capacity multiple linear regression equation's r^2 value, as shown in Table 4, was 99.10%. This suggests that the Equation 3 multiple linear regression model might adequately explain 99.10% of the variation in the sifting capacity experimental data. Similar to Solaiman *et al*. (2016), this showed that when the multiple linear regression model's r^2 is close to 100%, experimental data may be adequately explained.

According to the investigation, the Adj r^2 score for the sifting capacity multiple linear regression model was 98.54%. As a result, one could presume that the model's accuracy is 98.54%. The sifting capacity measurement data of the machine may be accurately represented by this model. Furthermore, the sifting capacity predicted r^2 or r^2(pred.) was 97.45%. This showed that the multiple linear regression model (Equation 3) could predict 97.45% of the sifting capacity data. Palkar and Shilapuram (2015) suggested that in order for the constructed regression model to be considered highly dependable, the difference between r^2(adj.) and r^2(pred.) must be less than 20. According to the analysis, there is a difference of 1.09 between r^2(adj.) and r^2(pred.) for the sifting capacity. The created multiple linear regression model (Equation 3) for the sifting capacity of the machine was generally deemed to be highly significant based on the p-value, r^2, r^2(adj.), and r^2(pred.) criteria. The estimated multiple linear regression model created for the sifting capacity suggested that it explained above 95% of the dataset's variability.

Table 3. Observed and Model Prediction Results

Observation	Sc (Observed), kg/hr	Sc (Predicted), kg/hr	SE Fit
1	153.00	150.07	9.37
2	308.00	299.74	9.37
3	152.00	149.41	9.37
4	78.00	75.74	9.37
5	154.00	175.74	9.37
6	228.00	225.41	9.37
7	102.00	100.07	9.37
8	453.00	453.74	9.37
9	52.00	50.07	9.37
10	225.00	180.74	9.37
11	150.00	154.41	9.37
12	75.00	80.74	9.37
13	150.00	155.07	9.37
14	225.00	230.41	9.37
15	450.00	458.74	9.37
16	50.00	55.07	9.37
17	100.00	105.07	9.37
18	300.00	304.74	9.37
19	457.00	447.52	9.37
20	97.00	93.85	9.37
21	73.00	69.52	9.37
22	146.00	143.85	9.37
23	145.00	143.19	9.37
24	47.00	43.85	9.37
25	147.00	169.52	9.37
26	222.00	219.19	9.37
27	290.00	293.52	9.37

Table 4. Estimated Coefficients for S_c Multiple Linear Regression Model

Term	Coefficient	SE Coefficient	P-Value
Constant	186.26	2.83	0.000
Blocks			
1	5.41	4.00	0.195
2	-5.81	4.00	0.165
3	0.41	4.00	0.920
Mm			
30	-94.93	4.00	0.000
60	-3.37	4.00	0.411
90	98.30	4.00	0.000
T			
0.2	-78.04	4.00	0.000
0.4	-36.26	4.00	0.000
0.6	114.30	4.00	0.000
Mm*T			
30 0.2	36.37	5.65	0.000
30 0.4	20.26	5.65	0.002
30 0.6	-56.63	5.65	0.000
60 0.2	-5.19	5.65	0.373
60 0.4	3.04	5.65	0.598
60 0.6	2.15	5.65	0.709
90 0.2	-31.19	5.65	0.000
90 0.4	-23.30	5.65	0.001
90 0.6	54.48	5.65	0.000

r^2 = 99.10%, Adj r^2 = 98.54%, r^2(Pred) = 97.45%

$$S_c = \alpha + \beta_1 Mm_1 + \beta_2 Mm_2 + \beta_3 Mm_3 + \beta_4 T_1 + \beta_5 T_2 + \beta_6 T_3 + \beta_{11} Mm_1 T_1 + \beta_{12} Mm_1 T + \beta_{13} Mm_1 T_3 + \beta_{21} Mm_2 T_1 + \beta_{22} Mm_2 T_2 + \beta_{23} Mm_2 T_3 + \beta_{31} Mm T_1 + \beta_{32} Mm_2 T_2 + \beta_{33} Mm_3 T_3 \quad (3)$$

4.4 Optimal Response (Sifting Capacity)

The Figure 4 shows the sifting capacity optimization plot, and Table 5 displays the findings of the best possible solution. The maximum throughput capacity was estimated to be 453.333 kg/hr based on the analysis. At a cassava mash mass of 90 kg and time of operation of 0.6 hr, the required reaction was obtained, and the composite desirability (D) was 0.991057, which was higher than 0.90 and near 1.00. As a result, the optimization plot's suggested optimal conditions (Figure 4) and Table 5's optimal solution results were largely trustworthy and completely consistent with the multiple linear regression model that was created. This akin to the finding of Ajanwachuku and Ekemube (2025) that optimized throughput capacity of cassava dewatered mash sifting machine.

Table 5. Optimization Simulation Result

Solution	Mm	T	Sc, kg/hr Fit	Composite Desirability
1	90	0.6	453.333	0.991057
2	60	0.6	299.333	0.615447
3	90	0.4	225.000	0.434146
4	90	0.2	175.333	0.313008
5	60	0.4	149.667	0.250407
6	30	0.6	149.000	0.248780
7	60	0.2	99.667	0.128455
8	30	0.4	75.333	0.069106
9	30	0.2	49.667	0.006504

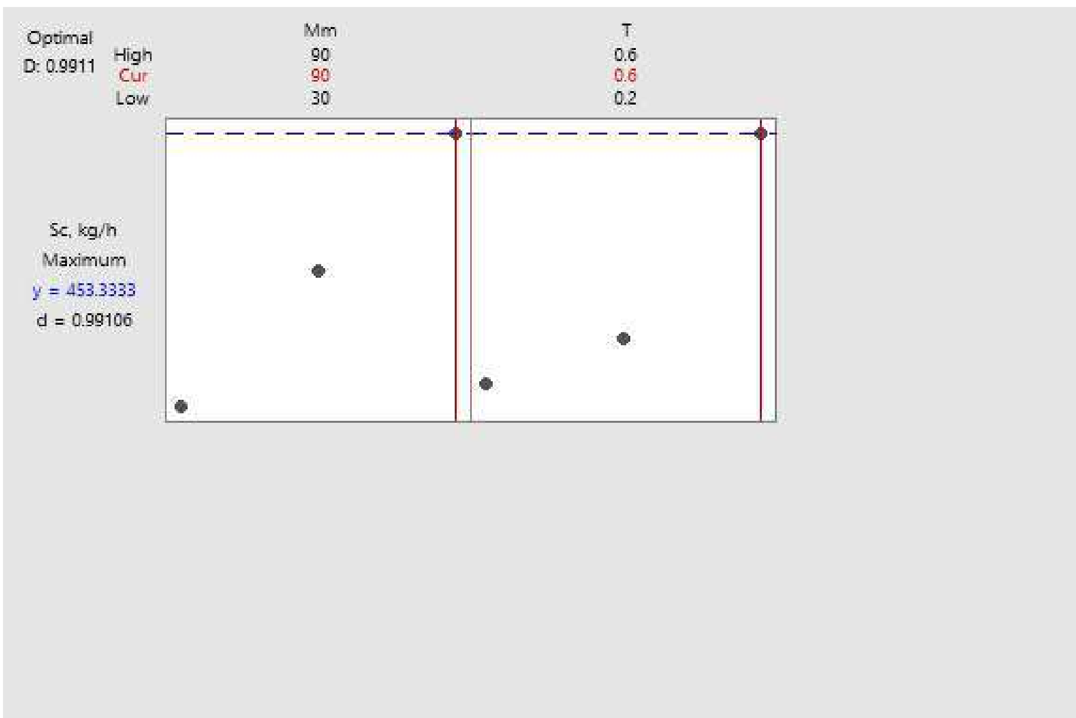

Figure 4. Optimization Plot

4. CONCLUSION

General full factorial design (GFFD) has been successfully used in the design of experiment (DOE) to optimize the sifting capacity in order to maximize the utilization of an improved dewatered cassava mash sifting machine and set optimal operating conditions. The following findings were drawn from the GFFD analysis: According to this study, the sifting capacity of the sifting machine under investigation was enhanced by the use of cassava mash mass and operating time. The analysis of variance (ANOVA) revealed that the mass of cassava mash and operating duration had a significant effect on sifting capacity ($P<0.05$). This implies that changes in cassava mash mass of 30, 60, and 90 kg had an impact on the sifting capacity when using developed machine operation Additionally, variations in operation time of 0.2, 0.4, and 0.6 hours had an impact on the sifting capacity. Additionally, the interaction between cassava mash mass and operating duration had a substantial (P<0.05) effect on the sifting capacity. According to a numerical method for examining the impacts of cassava mash mass and operating time on sifting capacity, changes in cassava mash mass and operating time frequently have an impact on sifting capacity. Using a numerical method to investigate the effects of cassava mash mass and operating time on sifting capacity, a multiple linear regression model was developed to forecast sifting capacity during cassava mash sifting. The models show the coefficients of the sifting capacity multiple regression model. It was confirmed that the models have a prediction accuracy of over 95%. The ideal sifting capacity during shifting was reached at a 90 kg cassava mash mass and a 0.6 hr operating period.

REFERENCES

Ahiakwo, A. A., Isirima, C.B., and Inimgba, D.G. (2015). Appraisal and Projection of Cassava Mash Sieving Technology. *Net Journal of Agricultural Science*. 3(2): 49-55, ISSN: 2315-9766

Ajanwachuku, N. C., and Ekemube, R. A. (2025) Optimization of Throughput Capacity of an Improved Dewatered Cassava Mash Sifting Machine Using General Full Factorial Design. *Journal of Engineering for Development*, *17*(1), 71 – 86.

Ajanwachuku, N. C., Nkakini, S. O., and Igoni, A. H. (2021). Development and Performance Evaluation of an Improved Garri Mash Sifter. *Journal of Newviews in Engineering and Technology*, 3(4), 110 – 120.

Akinoso, R., Olayanju, T. M. A., and Adebowale, A. A. (2018). Performance Evaluation of a Developed Motorized Cassava Sifter. *Journal of Food Processing and Preservation*, 42(2), e13480. https://doi.org/10.1111/jfpp.13480

Al-Hassani, A. A., Abbas, H. F., and Wan Daud, W. M. A. (2014). Hydrogen Production via Decomposition of Methane Over Activated Carbons as Catalysts: Full Factorial Design. *International Journal of Hydrogen Energy*, 39, 7004–7014.

Alabi, O. O. (2009). Design, Fabrication and Performance Evaluation of a Cassava Lump Breaking and Sieving Machine. An Unpublished HND Project. Department of Agricultural and Water Resources, Kwara State Polytechnic Ilorin, Kwara State.

Alonge, A. F., Ekanem, S. S., & Ituen, U. U. (2012). Development of a Cassava Pelleting Machine. Journal of Agricultural Engineering and Technology (JAET), 20(2): 29-37.

Ciopec, M., Davidescu, C. M., Negrea, A., Grozav, I., Lupa, L., Negrea, P., and Popa, A. (2012). Adsorption Studies of Cr (III) Ions from Aqueous Solutions by DEHPA Impregnated onto Amberlite XAD7—Factorial Design Analysis. Chemical Engineering Research and Design, 90(10), 1660–1670.

Ekemube, R.A., Atta, A.T., Buhari, F.A., and Olaniyi, G.O. (2024). Optimization of Fuel Consumption during Ploughing Operation on Tractor Tilled Area. Moor Journal of Agricultural Research, 25: 18 – 27.

Ekemube, R. A., Atta, A. T., Nkakini, S. O., and Opurum, A. N. (2023a). Use of Design of Experiment to Optimize Tractor Hourly Fuel Consumption during Harrowing Operation. Agricultural Mechanization in Asia, Africa and Latin America (AMA), 54(04), 13555 - 13574.

Ekemube, R. A., Atta, A. T., and Ndirika, V. I. O. (2023b). Optimization of Fuel Consumption for Tractor-Tilled Land Area During Harrowing Operation Using Full Factorial Experimental Design. *Covenant Journal of Engineering Technology, 7*(2), 57 – 70.

Food and Agriculture Organization (1997). Feeding Pigs in the Tropics. Food and Agriculture Organization Animal Production and Health Paper 132. Rome

Jackson. B. A. and Oladipo, N. O. (2013). Evaluating Sifting Efficiencies of a Dewatered Cassava Mash Sifter at Different Operating Speed. African Journal of Agricultural Research, 8(23): 2819 – 2824.

Javed, M. F., Amin, M. N., Shah, M. I., Khan, K., Iftikhar, B., Farooq, F., Aslam, F., Alyousef, R., and Alabduljabbar, H. (2020). Applications of Gene Expression Programming and Regression Techniques for Estimating Compressive Strength of Bagasse Ash Based Concrete. Crystals, 10, 737.

Kudabo, E. A., Onipede, E. A., and Adegbenro, A. A. (2012). Design, Fabrication and Performance Evaluation of an Improved Cassava Mash Sifter. *Journal of Agriculture and Veterinary Sciences*. 4:53-64.

Montagnac, J. A., Davis, C. R., and Tanumihardjo, S. A. (2009). Nutritional Value of Cassava for use as a Staple Food and Recent Advances for Improvement. *Comprehensive Reviews in Food Science and Food Safety*, 8(3), 181–194. https://doi.org/10.1111/j.1541-4337.2009.00077.x

Mutuk, T., and Mesci, B. (2014). Analysis of Mechanical Properties of Cement Containing Boron Waste and Rice Husk Ash using Full Factorial Design. Journal of Cleaner Production 4(69): 128–132.

Omodara, M. A., Adetunji, M. O. and Adegbite, A. E. (2020). Design and Performance Evaluation of a Rotary Sifter for Cassava Mash. *Nigerian Journal of Technological Development*, 17(1), 18-23. https://doi.org/10.4314/njtd.v17i1.3

Oni, K. O., Alakali, J. S. and Akpapuman, M. A. (2009). Design, Fabrication and Performance Evaluation of a Powered Soy-Gari Mixer. *Journal of Engineering and Applied Sciences*, 4 (3); 164 -169.

Ovat, F. A., and Odey S. O. (2018). Development and Performance Evaluation of a Motorized Garri Sieving Machine. European Journal of Advances in Engineering and Technology. 5(7): 459-465.

Palkar, R. R., and Shilapuram, V. (2015). Development of a Model for the Prediction of Hydrodynamics of a Liquid–Solid Circulating Fluidized Beds: A Full Factorial Design Approach. Powder Technology, 280: 103 – 112.

Prakash, O., Talat, M., Hasan, S. H., and Pandey, R. K. (2008). Factorial Design for the Optimization of Enzymatic Detection of Cadmium in Aqueous Solution using Immobilized Urease from Vegetable Waste. Bioresource Technology, 99: 7565–7572.

Solaiman, A., Suliman, A. S., Shinde, S., Naz, S., and Elkordy, A. A. (2016). Application of General Multilevel Factorial Design with Formulation of Fast Disintegrating Tablets Containing Croscaremellose Sodium and Disintequick MCC-25. International Journal of Pharmacy, 501: 87–95.

Sulaiman, M. A., and Adigun, R. A. (2008). Fabrication of Cassava Lump Breaker. An Unpublished Project Report Submitted to the Department of Mechanical Engineering, Kwara State Polytechnic, Ilorin