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POULTRY FEED MIXING MACHINE DESIGN ANALYSIS

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ABSTRACT

The idea of mixing various feed materials such as grains, feed supplements and other animal feeds to produce a homogenous mix ready for dispensing for animal consumption had being part of man's activities since the creation of man. This has always been done using crude method such as hands, sticks etc. in this recent time, the advancement in technology has brought about the use of machines to perform the same function much faster, accurate and less energy consuming, it is for this purpose that the feed mixing machine has been designed. There is a universal demand for poultry feed due to its use in domestic poultry as a machinery for food production. Our small-scale industries in the country are in dire need of a highly nutritious poultry feed for their birds to increase production output. Food is one of the most important basic needs of animals like the hogs in order to survive. Design analysis is a powerful software technology for simulating physical behavior on the computer. Will it break? Will it deform? Will it get too hot? These are the types of questions for which design analysis provides accurate answers. Instead of building a prototype and developing elaborate testing regimens to analyze the physical behavior of a product, engineers can elicit this information quickly and accurately on the computer. Because design analysis can minimize or even eliminate the need for physical prototyping and testing**,** the technology has gone mainstream in the manufacturing world over the past decade as a valuable product development tool and has become omnipresent in almost all fields of engineering. The principle of operation is a very simple one. Already crushed poultry feed ingredients are placed between stationary drum and the rotating inclined blades agitates the feeds which mixes the various poultry feed ingredients as a result forces between the poultry feeds and the stationary drum on one hand and the frictional forces between neighboring feeds. The making of poultry feeds which has hitherto been regarded as an exclusive function of the poultry farmer can be done by anybody who will need a little training on the operation of the machine, in addition time and space is a major advantage as not only that the long duration normally involved has been reduced but the numerous containers ranging from mortar, pestle, basin etc, have been limited to the machine. The machine was designed using solid work/solid edge design software and suitable material selection was done before the couplings and construction of parts. The efficiency of the machine, its associated cost of production and the product obtained after few minutes of mixing were outstanding, thereby, making the design acceptable and cost effective.

KEYWORDS: Design Analysis, Modelling, FEA, Poultry Feed, and Mixing Machine.

1. INTRODUCTION

There are six main nutrients in animal feed, these comprises of water, protein, carbohydrate, fats, mineral elements and vitamins. These six nutrients are vital to animal survival. Variations therefore exists in nutrient requirements for different farm animals, but the level of dietary energy and associated nutrient should be high enough to allow expression of animal potentials under certain environmental circumstances within the economic limitations [1]. These have to be combined in such a proportion that the feed produced will contain the requirements for the different classes and ages of poultry without any waste and at the cheapest cost. Machineries are required for the purpose of mixing of ingredients for animal feed.

Traditionally, small scale poultry breeder uses manual or hand to mix the crushed feed. In the medium scale production, feed mixing can be done either manually or mechanically. The manual method of mixing feed entails the use of shovel to intersperse the feed's constituents into one another on open concrete floors [2]. The manual method of mixing feed ingredients is generally characterized by low output, less efficient, labor intensive and may prove unsafe, hence, hazardous to the health of the intended animals, birds or fishes for

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which the feed is prepared. The mechanical method of mixing is achieved by using mechanical mixers developed over the years to alleviate the shortcomings associated with the manual method. A satisfactory mixing process produces a uniform feed in a minimum time with a minimum cost of overhead, power, and labour. Some variation between samples should be expected, but an ideal mixture would be one with minimal variation in composition [3]

The use of hand to mix the crushed poultry feed by the traditional agricultural sector characterized by subsistence farming was perhaps the first form of poultry feed mixer. This method was subsequently developed by the use of manually operated machine.

.There is a universal demand for poultry feed due to its use in domestic poultry as a machinery for food production. Our small-scale industries in the country are in dire need of a highly nutritious poultry feed for their birds to increase production output. The necessity to boost and sustain the economy which require a well-planned industrialization to suit local conditions and demand could accelerate the pace and scope of industrialization by increasing the level of our designing and manufacturing (computer-aided) rather than mere assembling activities such an effort would reduce importation of machines, spare parts and components that can be produced locally [4-7]

The major constraint is that of the source of power. The machine has an electric motor which utilizes electricity, the cheapest source of power so far. The motor selection has been done with consideration given to the torque speed and hence the power requirement [8]. For a rapid or sustainable economic development in Nigeria and Africa at large, a developed agricultural sector is necessary. A means of alleviating this problem is the provision of modern facilities made locally at cheaper rates. This will lead to increased productivity in agriculture which could enable manufacturer and consumers to benefit from the supply of relatively cheaper and better produce at the right time and in sufficient quantity. For these demands to be met to maintain a sustainable economic growth in Nigeria, a much higher production level in the agricultural sector is necessary through the use of locally designed and fabricated equipment based on its efficiency, durability, less capital intensive, strength and rigidity [9]. Unprofessional admixing of liquid components in the main mixer can causes insufficient homogeneity by formation of agglomerates and deposits on the mixing tools and walls. These deposits as sticks and crusts cause carry-over and cross contamination stochastically which cannot be compensated by rinsing batches. Mainly in cases of the mixing process by ribbon mixer, solid dispersed components have a better suitability than liquids.

The objective of this paper was, therefore, to design and fabricate a multi-purpose industrial tumble drum mixer at a cheaper and more affordable prices to our farmers, this work aims at producing feeds for poultry birds. It seeks to develop a model that will use electrically operated industrial poultry feed tumble mixer which arises from the fact that most of the locally produced feeds has undergone primitive and inefficient means of manual processing. This machine will be designed and fabricated with a view to reducing the dependency of manual operation and making convenience by reducing human effort and time by exploring the various principles associated with machine design. The principle of operation is a very simple one. Already crushed poultry feed ingredients are placed between stationary drum and the rotating inclined blades agitates the feeds which mixes the various poultry feed ingredients as a result forces between the poultry feeds and the stationary drum on one hand and the frictional forces between neighboring feeds. The making of poultry feeds which has hitherto been regarded as an exclusive function of the poultry farmer can be done by anybody who will need a little training on the operation of the machine, in addition time and space is a major advantage as not only that the long duration normally involved has been reduced but the numerous containers ranging from mortar, pestle, basin etc, have been limited to the machine [10]

2. DESIGN ANALYSIS

Finite Element Analysis (FEA) Design Analysis employs the finite element analysis (FEA) method to simulate physical behavior of a product design. The FEA process consists of subdividing all systems into individual components or “elements” whose behavior is easily understood and then reconstructing the original system from these components. This is a natural way of performing analysis in engineering and even in other analytical fields, such as economics. For example, a control arm on a car suspension is one continuous shape. An analysis application will test the control arm by dividing the geometry into ‘elements,’ analyzing them, then simulating.

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what happens between the elements? The application displays the results as colour-coded 3D images, red usually denoting an area of failure, and blue denoting areas that maintain their integrity under the load applied. illustrated in Fig 4 A-D and table 1 below. In the field of mechanical engineering, design analysis can solve a wide range of product development problems. Engineers can use design analysis to predict the physical behavior of just about any part or assembly under any loading conditions: from a simple beam under a bending load to car crash simulations and vibration analysis of aircraft. The true power of design analysis is the ability to perform any of these types of studies accurately without building a single thing. All that is needed is a CAD model, shown in fig 1-3,5,6

Manual feed mixing process

Most of the poultry farmers still employ crude techniques for processing their poultry feeds. For example, some still use hand and basins to mix already crushed poultry, some also use shovel to intersperse the feed‟s constituents into one another on open concrete floors (as represented [11]), all of which are labour intensive and hazardous While other categories of local farmers, according to the work of [8], uses drum mixer to mix their poultry feed. This aspect of manual mixing [12]) is much healthier for the birds and better in efficiency and output, than the use of shovel or hands and basin. Nevertheless, their outputs and efficiencies are not to be reckoned with in production of poultry feed in a proper commercial poultry farm. Besides, the drum mixer encourages segregation of feed particles

Mechanical mixing process

Mechanical mixing is one of the most important unit operations in livestock feed manufacturing. The purposes of which, after size reduction of different feed ingredients, is to aid palatability of feed, minimizes waste during animal feeding, facilitates easy packaging, and enhances post-production storage and preservation. The mechanical method of mixing as described earlier is achieved by using mechanical mixers or machineries for the purpose of mixing feed. The work by [13] developed and tested an animal feed mixing machine which was tested using a feed components divided into three equal measures of 50 kg for ground corn, 0.265 kg for cassava flour and 2.65 kg for shelled corn replicated thrice (according to the standard test procedure developed by [14]) at four mixing durations of 5, 10, 15 and 20 min. A mixing performance of up to 95.31% was attained in 20 minutes of operation and evacuation of mixed materials from the mixer was observed to be almost complete and was accomplished in 9 minutes with the mixer at full capacity (60 kg of feed ingredients or two third of the mixing chamber filled) while the average value of coefficient of variation for the three replicates was 4.69%. The performance test at the end of each test run, ten samples of 500 g were drawn from the mixed components and the coefficient of variation among blended samples and mixing levels. were computed. [15]

3. LITERATURE REVIEW

The beginning of industrial scale production of animal feeds can be traced back to the late 1800s, this is around the time that advance in human and animal nutrition was able to identify the benefits of a balanced diet, and the importance or role the processing of certain raw materials played in this. Corn gluten feed mixer was first manufactured in 1882, while leading world feed producer Purina feeds was established in 1894 by William H Danforth. Cargill which was mainly dealing in grains from its beginning in 1865, started to deal in feed mixer production at about 1884. The feed industry expanded rapidly in the first quarter of the 1900s with “Purina” expanding its operations into Canada and opened its first feed mill in 1927.

In 1908 Herbert Johnson, an engineer for the Hobart manufacturing company, invents an electric mixer. His inspiration came from observing a baker mixing bread dough with a metal spoon; soon he was toying with a mechanical counterpart. By 1915, his 80-quart mixer was standard equipment. In 1908 the feed industry was revolutionized by the introduction of the first feed mixer used for mixing pelleted feeds. It could be cited that the poor quality products of feed could be as a result of improper mixing of feed. Again, large quantities of feed will be very difficult to mix by hand if not impossible, thereby producing poor quality products and reducing production rate. This lowers the profits margin of the products. On the other hand, the cost of importation of foreign machine for mixing feed is very high compared to the producer‟s mega resources.

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Generally, this affects the country‟s foreign reverse. Also it tends to bring down the cost of the machine to the reach of the small scale producers. Besides it creates employment opportunities for the farmers, this design was chosen for reliabilities among other things discussed in the under the heading „‟conclusion [16]

History of Simulation

The historical perspective of simulation is as enumerated in a chronological order. 1940: A method named „Monte Carlo‟ was developed by researchers (John von Neumann, Stanislaw Ulan, Edward Teller, Herman Kahn) and physicists working on a Manhattan project to study neutron scattering. 1960: The first special-purpose simulation languages were developed, such as SIMSCRIPT by Harry Markowitz at the RAND Corporation. 1970: During this period, research was initiated on mathematical foundations of simulation 1980: During this period, PC-based simulation software, graphical user interfaces and object-oriented programming were developed.

1990: During this period, web-based simulation, fancy animated graphics, simulation-based optimization, Markov-chain Monte Carlo methods were developed.

Developing Simulation Models

Simulation models consist of the following components: system entities, input variables, performance measures, and functional relationships. Following are the steps to develop a simulation model.

Step 1: Identify the problem with an existing system or set requirements of a proposed system.
Step 2: Design the problem while taking care of the existing system factors and limitations.
Step 3: Collect and start processing the system data, observing its performance and result.
Step 4: Develop the model using network diagrams and verify it using various verifications techniques.
Step 5: Validate the model by comparing its performance under various conditions with the real system.
Step 6: Create a document of the model for future use, which includes objectives, assumptions, input variables and performance in detail.
Step 7: Select an appropriate experimental design as per requirement.
Step 8: Induce experimental conditions on the model and observe the result

Performing Simulation Analysis

Following are the steps to perform simulation analysis.

Step 1: Prepare a problem statement.
Step 2: Choose input variables and create entities for the simulation process. There are two types of variables - decision variables and uncontrollable variables. Decision variables are controlled by the programmer, whereas uncontrollable variables are the random variables.
Step 3: Create constraints on the decision variables by assigning it to the simulation process.
Step 4: Determine the output variables.
Step 5: Collect data from the real-life system to input into the simulation.
Step 6: Develop a flowchart showing the progress of the simulation process.
Step 7: Choose an appropriate simulation software to run the model

4. METHODOLOGY

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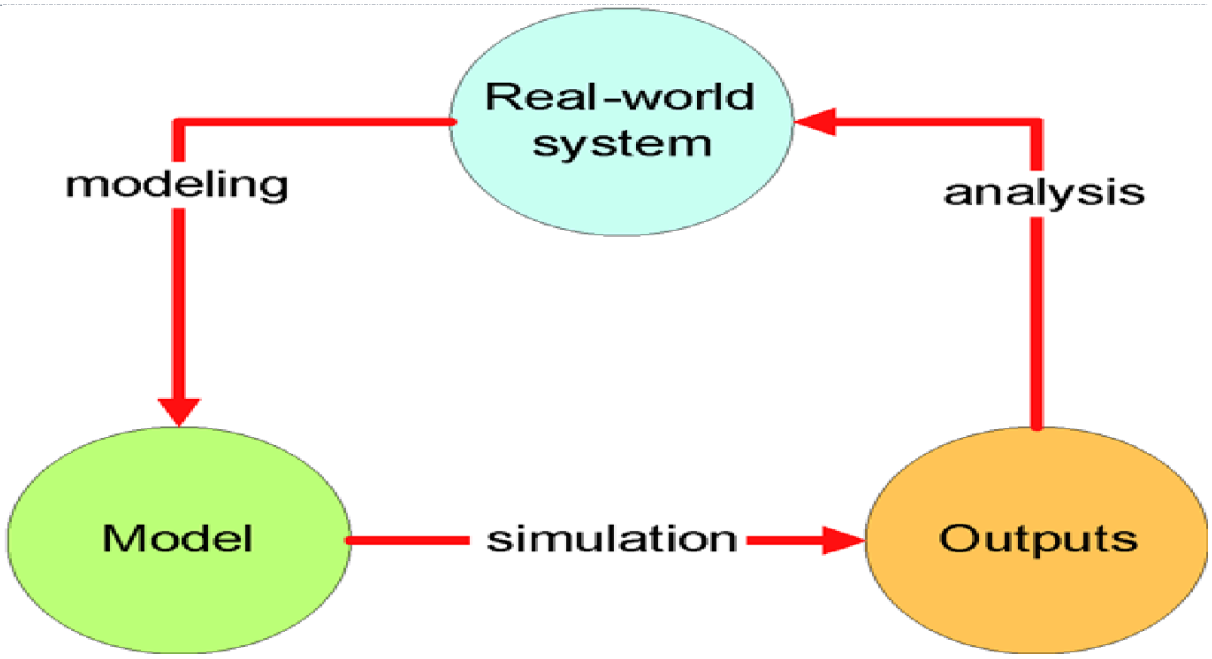

1) Design
2) Modelling
3) Simulation
4) analysis

Banks et al. (2009)

Modelling and simulation of poultry feed mixing machine and the major components

Fig 1 final Design

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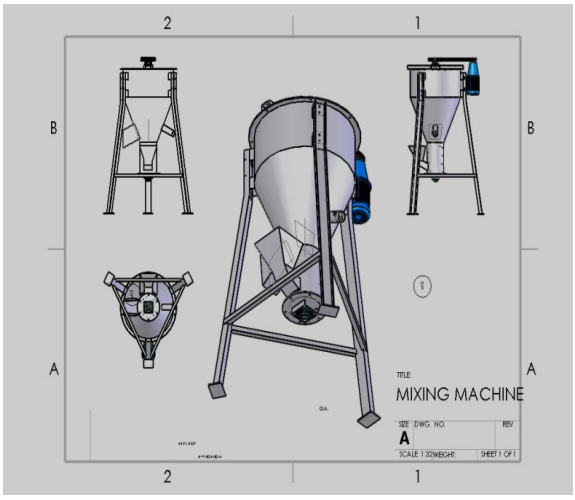

Fig 2 Multiply Views of the Machine

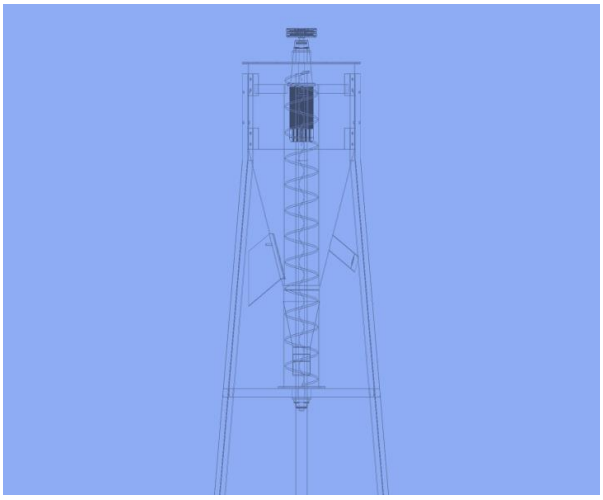

Fig ;3 wire Frame

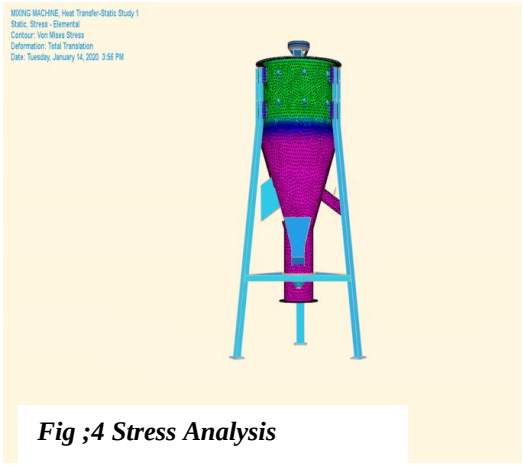

Fig ;4 Stress Analysis

Fig; 4 E

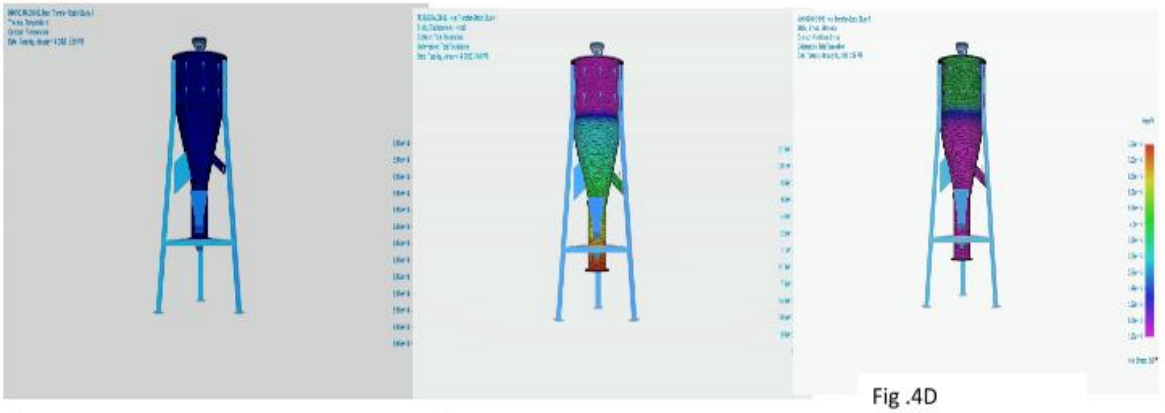

Fig ;4 B

Fig ;4C

Fig .4D

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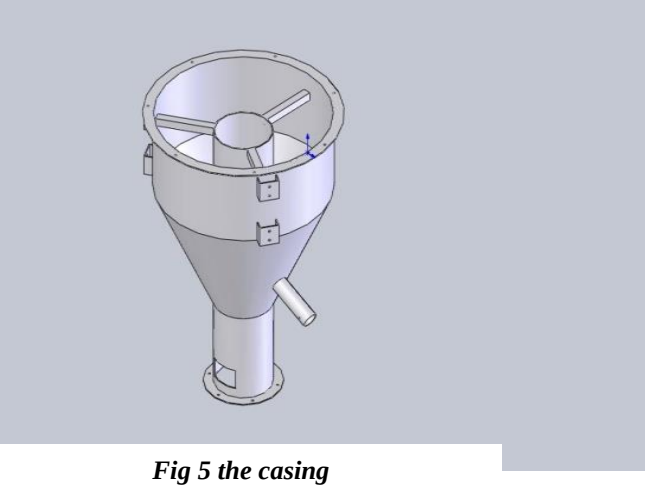

Fig 5 the casing

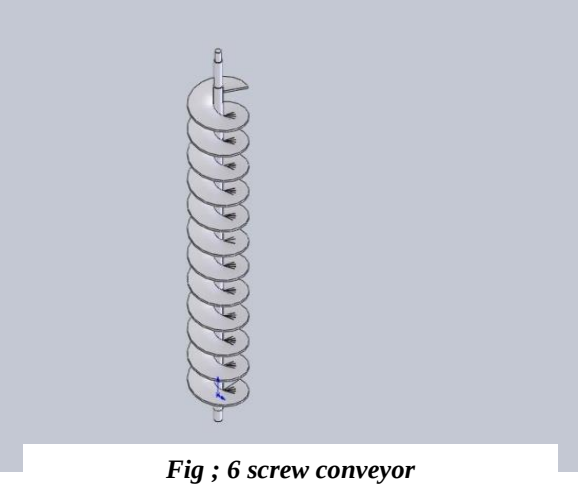

Fig ; 6 screw conveyor

Thermal Results

Result component: Temperature				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	9.65e+14 C	30.876 mm	928.599 mm	38.538 mm
Maximum	9.65e+14 C	30.876 mm	928.599 mm	38.538 mm

Stress Results

Result component: Von Mises				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	1.83e+10 MegaPa	446.576 mm	156.233 mm	223.900 mm
Maximum	7.89e+15 MegaPa	10.876 mm	1063.599 mm	656.199 mm

Factor of Safety Results

Result Component: Factor of Safety				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	3.23e-14	10.876 mm	1063.599 mm	656.199 mm
Maximum	1.39e-08	446.576 mm	156.233 mm	223.900 mm

Table 1 FEA Analysis

Static

Displacement Results

Result component: Total Translation				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	0 mm	-384.116 mm	928.599 mm	392.154 mm
Maximu	2.19e+13	-82.806	-431.401	363.901

Stainless Steel, 303

Property	Value
Density	8027.000 kg/m^3
Coef. of Thermal Exp.	0.0000 /C
Thermal Conductivity	0.017 kW/m-C
Specific Heat	502.000 J/kg-C
Modulus of Elasticity	193053.196 MegaPa
Poisson's Ratio	0.290
Yield Stress	255.106 MegaPa
Ultimate Stress	579.160 MegaPa

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Stress Analysis
The most common design analysis application in the field of mechanical engineering is stress analysis. Engineers study the stresses (both structural and thermal) on a part to determine whether it will fail or not and whether design modifications are necessary to overcome potential problems. Design analysis can be used in a wide variety of fields, here are just a few examples:

- Determine the potential for deformation of parts
- Measure resonant frequencies and modes of vibration of parts and assemblies
- Calculate dynamic and seismic responses
- Determine Contact stresses
- Provide temperature distribution
- Analyze fluid flow, whether it be a gas or liquid in a pipeline, the mixture of air and fuel in an engine intake manifold, or molten plastic filling up a mold.

Motion Analysis & Electromagnetic
Besides working very closely with CAD packages, commercial design analysis applications also interface with increasingly popular programs for motion analysis to create complete virtual analysis and test systems. In other engineering disciplines, design analysis is used to study electromagnetic fields, soil mechanics, groundwater flow, bone growth, etc. [17]

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5. POULTRY FEED MIXING MACHINE DESIGN ANALYSIS

It was observed that, for the mechanization of agriculture in Nigeria to succeed. It must be based on indigenous design, development, and manufacture of most of the required machines and equipment, to ensure their suitability for the crops as well as for the farmers‟ technical and financial capabilities. The above illustration shows how theme of our research project was derived. For the United Nation Sustainable development goals, to be reached, everyone needs to do their part: governments, the private sector, civil society and people like you, that is why we are making our contributions, [18] Do you know that the Average Nigerian Farmer is still making use of only the same Out-dated Manual Farm Tools - like Cutlass and Hoe - as their Fore-fathers used since many Centuries ago? Do you also know that instead of using some Affordable Modern Agricultural Techniques or Simple Machines; the Farmers in that part of the World Have Changelessly, adhered to various Archaic Agricultural Methods and Practices that were Copied from their Ancestors? In short, their use of these kinds of Archaic and Out-dated Tools and Techniques, constitutes a very great set-back in the Country's Food and Agricultural Out-puts.

Investment in agricultural science and technology, generally in the form of research and extension services, has proved to be highly valuable for improving crop yields and lessening poverty in developing countries. Nevertheless, such investments should reflect all the parties‟ needs for knowledge (World Bank 2007b). There is broad consensus that innovation is critically important for meeting the challenges race, including the need to improve competitiveness, sustainability and equality in agriculture.

Agriculture also needs to produce more food for a growing population, using a limited amount of farmland, while at the same time reducing its greenhouse gas emissions to avoid worsening climate change. This suggests that agricultural production needs to use more intensively, which means it must innovate. The benefits of the topic are summarized below [19] Income generation as a benefits of poultry; No doubt it, poultry farming is a source of generating income. No amount of money spends in setting up a poultry farm that is waste, you will surely make gain from your investments

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Take for instance, with just N 40,000 ($127) you will successfully raise 100 broilers just 6 to 8 weeks before you will start selling them.

When your broilers are 6 weeks old, you can start selling them, by selling them N 650 to 700 per one, at the end you will be getting about N 65,000 ($206) and N 70,000 ($223) the end. By calculation, you will be having between N 25,000 ($70) and N 30,000 ($ at the end.
Therefore, no amount of money you invest that you will not get from it, so just give it a today you will make it

1. Employment opportunity as a benefits of poultry
2. Small capital to start as a benefits of poultry
3. It gives rapid return on investment is also a benefits of poultry
4. Poultry farming is a continuous source of income
5. Poultry farming require little water
6. Poultry dropping are sources of fertilizer is also a benefits of poultry
7. Poultry farm offer full or part time employment opportunity therefore a benefits of poultry

Poultry eggs and meat are highly nutritional value as parts of benefits of poultry and the benefits of the mixing machine to farmer are as ensuing [21]

Benefits of machine

- ***Cost Effective*:**

It has low as well as inexpensive cost within the wealthy and the unhealthy. Besides, it needs slight or no recurrent looking after

- ***Increase in Productivity*:**

Productivity increment brings about affluence increase of a nation. Productivity of poultry farmers drive maximally in bringing about extent of increase in productivity level of a nation which will rise worth totalling to GDP

- ***Poverty Reduction and Job Creation:***

Its assistance in job creation is enormous as seen it its necessitating reduction in the migration between rural-urban.

- ***Usage and Observation by Local Fabricators*:**

Ever since the machine is invented locally, the procedure drives local producers to modernize or improve in their construction. Therefore, cumulative the health rural

- ***Decrease in Joblessness***

The decrease of joblessness are those machine fabricators as well as those using the machine will be the recipients

- ***Inspire DIRECT as well as Indirect Investment*:**

It drive hastily growth in industrial creation for machine manufacturing as well as further feed processing projects. It will likewise intensify speedy growth and development of the nation's economy.

- ***Economic Improvement and Industrial development:***

It will help in economic improvement and industrial development for the reason that it necessitates the formation of fresh asset culture, affluence establishment as well as enlarged economic plus social welfare. Entirely, these brings about enhanced application of feed beforehand to avoid spoiled owing to small shelf life [20]

6. CONCLUSION

Many of the individual tasks within the overall design process can be performed using a computer. As each of these tasks is made more efficient, the efficiency of the overall process increases as well. The computer is well suited to design in four areas, which correspond to the latter four stages of the general design process. Computers function in the design process through geometric modeling capabilities, engineering analysis calculations, testing procedures, and automated drafting, from the result of testing and affordability in term of cost, it can be concluded that the project is successful, therefore software design should be encouraged in our institution of higher learning base on the following facts, long product development, countless trial and error, and accountability and limited profitability.

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REFERENCES

[1] Wilson, J. E. (1990). Raw Materials – Animal Protein. Feed Tech V Revised (Ist ed.)
[2] Grafman, L. (2007). Original: Small scale Manufacture of Compound Animal Feed 7 http://www.appropedia.org/Original:Small_scale_Manufacture_of_Compound_Animal _Feed_7
[3] Lindley, J. A. (1991). Mixing Processes for Agricultural and Food Materials, Journal of Agricultural Engineering Research 48:153-170.
[4] Akpobi J.A, Ovuworie G.C., Computer-Aided Design of the Critical Speed of Shafts, Journal of Applied Science and Environmental Management, 2008, 12, p. 79-86.
[5] . Akpobi J.A., Ardey M., Computer-Aided Design for Machine Vibrations, Technical Transactions of the Nigerian Institution of Production Engineers, 2002, 7(3), p. 41-62.
[6] . Akpobi J.A, Lawani I.A., Computer Aided Design of Flywheels, Advances in Engineering Software (Elsevier Publishers), 2006, 37(4), p. 222-235.
[7] . Okojie V.A., Software Approach in Solving Shaft Design Problems, Project Solutions Domain Journal of Mechanical Engineering, 2011, 1, p. 15-28.
[8] Ear T.S, Johnson B.P., Production engineering, Third Edition, Tata Mcgraw Hill Company Limited, New Delhi, 2007
[9] Khurmi R.S., Gupta J.K., A Textbook of Machine Design, Fourteenth Edition, S. Chand and Company Limited, New Delhi, 2005
[10] 7 Volosciuc, P. (2015). Granulator 300kg/h. www.youtube.com/watch?v=ELTmmy4x14g
[11] Peter, K. I. (2013). The organic farmer, (biovision). The magazine for sustainable agriculture in East Africa, No. 102. November 2013.
[12] http://www.biovision.ch/fileadmin/pdf/d/services/downloads/organic_farmer/org_farmer102_13_red.pdf
[13] Balami, A. A, Adgidzi, D, & Mua‟zu, A. (2013). Development and Testing of an Animal Feed Mixing Machine, International Journal of Basics and Applied Sciences, Insan Akademika Publications, P-ISSN: 2301 – 4458; E – ISSN: 2301-8038.
[14] ASAE Standards, (ASAE S380 DEC1975 R2006). Test Procedure to Measure Mixing Ability of Portable Farm Batch Mixers, pp. 261 – 262.
[15] Rufus Ogbuka Chime etal, (2018) Design, Modelling and Simulation of Feed Mixing Machine by Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 9(1): 44- 49 © Scholarlink Research Institute Journals, 2018 (ISSN: 2141-7016) Journal of Emerging Trends I
[16] https://www.javelin-tech.com/blog/
[17] A method named „Monte Carlo“
[18]]://Www.Javelintech.Com/3d/Technology/Solidworkssimulation
[19] Rufus Ogbuka Chime (2019) Sustainable Design in Palm Fruit Bunch Stripper Manufacturing by International Journal of Contemporary Applied Researches Vol. 6, No. 11, November 2019 (ISSN: 2308-1365) www.ijcar.net
[20] jaspafarm.blogspot.com/2016/08/benefits-of-poultry.html
[21] R.O.Chime Et al (2015)Improving Productivity In Feed Mixing Machine Manufacturing In Nigeria PUBLISHED By Ijser Volume6,Issue 10, Octomber 2015 Edition Www.Ijser.Org
[22] R.O.Chime ,F .O. Odo (2018)Analysis of Garri Frying Machine Manufacturing in Nigeria: Design Innovation published by Advances in Science, Technology and Engineering Systems Journal Vol. 3, No. 6, 403-411 (2018) www.astesj.com.