DESIGN AND FABRICATION OF A FIXED FLAT DIE POULTRY FEED PELLETISING MACHINE

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ABSTRACT

This study was undertaken to design and evaluate the performance of an electric motor-driven pellet mill intended for animal feed production. The developed pellet mill comprises several key components, including a feed hopper, pelleting chamber, pellet roll, die plate, and frame. It is powered by a 5 horsepower electric motor and operates utilizing a roll-type extrusion press to expel the formulated feeds through the die plate. As the pellet rolls rotate, they apply pressure that facilitates the rearrangement of particles, thereby filling the voids of the die plate. During the compression phase, the pressure increases, prompting brittle particles to fracture and malleable particles to deform, which allows them to be processed through the die and emerge as pellets. The pellets subsequently fall due to the impact generated by the rotating die plate. This apparatus is capable of producing pellets with a diameter of 5 mm and a length of 25 mm. An investment of #323,000 is necessary for the procurement of the pellet mill and the construction of its housing. Financial analysis indicates that utilizing the CPU-CARES Formulated Starter Mash for pelleting feeds would be a profitable endeavor, yielding a rate of return of 423% on the capital invested. Furthermore, the benefits realized amount to 16% of the incurred costs, and the initial investment, inclusive of housing, can be recouped in less than three months. Based on these findings, the pellet mill has demonstrated its ability to transform dusty mashed feeds into pellets, producing a considerable quantity of pellets daily.

CHAPTER ONE

INTRODUCTION

1.1 Background of study

Feed constitutes a significant expense in animal production. Consequently, the efficiency of feed utilization and the implementation of quality control measures can substantially influence the operational performance of agricultural enterprises (Halley and Scoffe, 1988; Hasting and Higgs, 2000; Elmer, 1990). The nutritional value of feed is predominantly determined by the extent to which an animal can assimilate the specific nutrients it contains to satisfy various physiological needs (Halley and Scoffe, 1988). The primary objective of processing livestock feed is to enhance the efficiency with which animals utilize these nutrients (Tillman and Waldroup, 1986; Kabuage, 1996). Historically, numerous straightforward and widely-used techniques have been applied in the processing of livestock feeds, primarily consisting of cereal grains and their byproducts. These techniques are categorized into hot or cold processes based on heat requirements, as well as into wet or dry processes. Common methods employed include grinding (or particle size reduction), crushing, rolling, steam-flaking, micronisation, roasting, chopping, cracking or crimping, popping, and both hot and cold pelleting (Halley and Scoffe, 1988; Harris, 1990; McDonald, 1987; FAO, 1997; Hasting and Higgs, 2000). Research indicates that feeding livestock with pellets produces significant benefits. Kabuage et al. (2000) observed that pelleting amaranth diets enhanced their nutritional value and positively influenced chick growth. Similarly, Salmatec (2000) asserted that highly compressed pellets facilitate easier storage and transportation, maximize space efficiency, prolong storage life, and enable the economical transport of large quantities. Furthermore, Galen et al. (2000) highlighted that pelleted feeds offer numerous advantages sought by livestock producers, including reduced feed wastage, diminished selective feeding behavior, enhanced feed efficiency, improved handling characteristics, eradication of undesirable microorganisms, and increased bulk density. They also noted that pelleting contributes to complete pasteurization, superior pellet quality—characterized by enhanced durability and a reduction in fines—increased feed utilization, heightened starch gelatinization, and the production of bypass fat and bypass protein. Such perspectives are echoed by other scholars including McDonald (1987), MikroTechnik (2002), Halley and Scoffe (1988), Salmatec (2000), Eugene (2002), and FAO (1997). Pelleting equipment is categorized into two primary types based on the die configuration: disc die and ring die pelleters (FAO, 1997). Generally, such equipment comprises a pelleting device, a steam generator, an oil and molasses doser, a cooling apparatus, a separator, and a sieve (Galen et al., 2000). It has been established that both the mean particle size or grind of ingredients and the formulation play a crucial role in the production of high-quality pellets (Galen et al., 2000; FAO, 2000). However, the adoption of livestock feed pelleting machinery is limited by the substantial costs associated with such equipment (FAO, 1997; Kabuage et al., 2000; Eugene, 2002). As a result, many local livestock farmers, particularly in Nigeria, find it challenging to afford advanced livestock feed pelleting machinery. This project aims to design and develop a cost-effective livestock feed pelleting machine and to evaluate its performance. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

A feed pallet making machine is a piece of equipment designed for the production of animal feed in the form of pallets. Animal feed, often a mixture of grains, proteins, vitamins, and minerals, can be processed and compressed into compact pallets using these machines. The resulting feed pallets are easier to handle, store, and transport, making them convenient for farmers and livestock owners. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

The machine typically involves processes such as grinding, mixing, and compressing raw materials to create uniform and nutritionally balanced feed. The size and composition of the pallets can be adjusted based on the specific nutritional requirements of the animals.

Using a feed pallet making machine offers several advantages, including efficient feed production, improved storage and transportation, and the ability to provide animals with a consistent and controlled diet. These machines are essential in the field of animal husbandry and play a key role in ensuring the health and productivity of livestock.

The use of pelleted feed for livestock presents significant advantages for both the animals and their owners, as it is economically viable and effectively supplies essential nutrients. Nonetheless, the high costs associated with feed pelleting machines pose challenges for local farmers. A pelleting machine is specifically designed for the production of feed in pellet form. This equipment is primarily employed in the processing of various powdery materials, as well as some solid materials of varying sizes, into pellets. It is typically utilized for both mass and batch production across several industries, including ceramics, agriculture, iron and steel, chemicals, pharmaceuticals, and cement, as well as in metallurgical workshops and related sectors. Given the increasing demand in the agricultural sector, researchers have commenced efforts to design a cost-effective machine capable of converting powdery feed materials into pellets. Such a machine is anticipated to exhibit high efficiency, thereby reducing farming costs and enhancing economic returns through income generation. The integration of this technology into agricultural practices is expected to make livestock rearing more appealing and contribute to job creation within the workforce. A feed pellet making machine is a device that compresses raw materials into pellets that can be used as animal feed. The process of making feed pallets involves passing the raw materials through the compression and hardening processes and the through holes cast in a particular shape and size.

Here are some general steps for operating a feed pellet making machine;

1. Connect the receiving tray with the pellet machine.
2. Add gear oil before starting the machine.
3. Connect the motor wires of the feed pellet machine.

4. Check if the rollers are loose.
5. Add materials to make pellets.

When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application.

1.2 Statement of the Problem

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1.3 Aim/objective

The aim of the current study is to design and fabricate a fixed flat die feed pelleting machine.

The objectives of the study are as follows;

i. Design of machine components.
ii. Fabrication of the said machine.
iii. Assembly, testing and modifications of the said machines.
iv. Evaluation of the machine.

1.4 Scope of study

The scope of study is the analysis of machine components such as the flat die and electric motor - roller mechanism. Assessing the structural design and the materials used for durability, stability, safety, evaluating the machines dimensions and portability for practicality and ease of use. Investigating the power source and energy efficiency of the machine.

1.5 Significance of study

The fabrication of a feed pellet making machine solves several problems in the livestock farming industry. Firstly, manual feed preparation processes can be labor-intensive and time-consuming, this problem can be solved by automating the production process, increasing efficiency, reducing labor costs, and allowing for higher production volumes.

Secondly, Traditional methods of feed preparation may lead to inconsistencies in nutrient distribution, affecting the health and productivity of animals but Feed pellet making machines ensure a uniform blend of nutrients in every pellet, providing animals with a balanced and consistent diet. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

Moreover, the Feed pellet making machines compress feed into compact pellets, making storage and transportation more convenient, saving space, and reducing the risk of spoilage. Palletization also involves a heat treatment process that can help reduce microbial contamination, contributing to better hygiene and disease prevention. And also, Pelleted feed offers a complete and uniform mix, minimizing the potential for selective feeding and reducing overall feed wastage.

Overall, the fabrication of a feed making pellet machine solves efficiency, nutrient consistency, disease control, storage and transportation problems in the animal feed industry by automating the palletization process. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent

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CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Feed is the major cost to animal production. Thus, quality control of its use, will have a considerable impact on the performance of an enterprise

(Ikebudu, 2015). The value of a feed is dependent on how much particular nutrients in the feed that the animal is able to utilize to meet the requirements of various body processes. Due to technological advancement grinding machines were developed for grinding of cereals and grain with the mixture of other nutrients into powder form. With time, it was discovered that the animals preferred feeding on solid and soft nutritious meal. Pelletizing machine is one of the devices required to produce such feed (Hasting W.H and Higgs D, 2008). When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

Moulding of animal feeds inform of capsules, small enough for easy consumption by fishes and poultry beds is the major function of pelleting machine. It equally used in iron ore for pellet production in varying sizes and same goes for chemical factories, where some chemicals are produced in pellets. Livestock feeds is processed with the aim of maximizing utilization efficiency of the nutrients (Califonia, 2017).

Studies have revealed that feeding certain livestock with pellets have great benefits. (Tillman P.B and Waldroup P.W, 1986) Noted that pelleting amaranth diets improved the nutritional value and was beneficial in improving growth of chicks. Kabuage L.W (2005) Also stated that highly compressed pellets facilitate storage and transportation, as large quantity of feeds could be carried economically from one location to the other. Pointed out some other advantages of pelleting feeds, which includes the saves made through decrease food wastage, improvement on feed efficiency, reduced selective feeding, control of undesired micro-organism, increase in bulk density and better handling characteristics. They added that quality addition to the feed include better durability and fewer fines of the pellets, complete pasteurization, increased utilization of feeds, starch gelatinization increment and production of by-pass fat and by-pass protein. Their views were shared by, (Mikro Technik Manufacturing co. Ltd, 2002) and (Joseph Orisaleye and A.B Fashina, 2009). According to Halley (1988), techniques have been developed years back on the way to process feeds for livestock. The feeds are basically on cereals and their by-products. The process is classified as either hot or cold depending on the required temperature (heat). It may equally be classified as wet or dry process. Different techniques adopted for this processes include particle size reduction or grinding, rolling, crushing, micro-organization, roasting, chopping, cracking or crimping, popping, hot and cold pelleting. This views was shared by (Harris, 2005; McDonald P, 1987; Hasting W.H and Higgs D, 2008). Meanwhile, Jeremy Mahrt (2014) revealed that similar techniques could be adopted for production of manure (fertilizer).

The importance of mean particle size or grind of ingredient and their formulations to production of high quality pellets was emphasized by Galen R and Brian P (2008). However, there is a limitation to the use of the livestock feed pelleting machine because of the high cost of the equipment for pellet processing (Joseph Orisaleye and A.B Fashina, 2009). Hence, the local livestock farmer, in Nigeria in particular, finds it very difficult to utilize the sophisticated livestock feed pelleting machine. Hence, the need for this project.

2.2 Working principle

The machine worked on a principle that it uses a roll-type extrusion press. The formulated feeds were fed into the pelleting chamber by the pellet rolls. As the pellet rolls rotated, force was also applied creating rearrangement of the particles in order to fill the voids or holes of the die plate. The pressure was increased in compression step, causing brittle particles to break and malleable particles to deform forcing them to be fed in the die and come out as pellets. The pellets then fell naturally due to the impact created by the rotating die plate , hence, a cutter was no longer needed. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

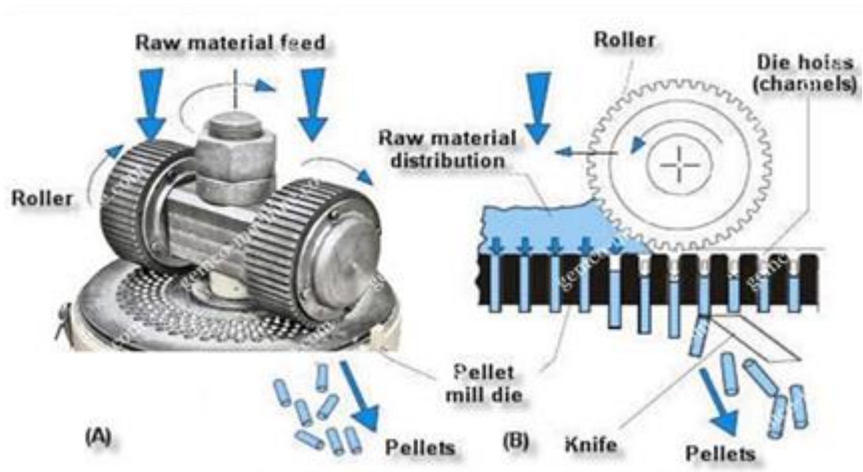

Plate 1.1: Working Principle

Plate 1.2: Fabricated machine

Plate 1.3: Quantity of pellets formed in one run of the machine

2.3 Machine Components

The feeding unit (hopper), pelleting chamber (die plate and press-roller encased in cylindrical chamber), pellet discharging and power transmission unit with accompanying frame combined together forms a rotating die and roller type portable pelleting machine. Feeding of thoroughly mixed ground feed ingredients to the pelleting machine was achieved manually. Feed mixture was extruded through die plate to form pellets while passing between the flat die and press roller. A small knife to cut the pelleted feed as they formed was also provided beneath the die plate. The clearance between the die and the press roller was kept to 0.5 mm, with provision for adjustment if required. The un-pelleted feed, if any, are separated from pelleted feeds within the pelletizer (through perforated screen which screens the pellets from un-pelleted feed, before it is discharged) and were used for re-feeding. Some assumptions were made from past work done on the pelleting machines design and are quoted wherever needed while designing machine components hereafter.

2.3.2 Feeding Unit

The feeding unit was designed to feed the mixture to the pelleting chamber. The feeding unit consists of an inverted truncated cone, gravity flow type hopper. The hopper volume of the pelleting machine is the function of pelleting capacity, bulk density of feed and number of loadings of the machine. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.3.3 Pelleting Chamber

The pelleting chamber is the hollow cylinder which houses the die plate, press-rollers, clearance adjustment mechanism (between die plate-roller), pellet cutting knife, perforated pellet separator plate & pelleted and un-pelleted feed outlets. The die plate is considered as the heart of the pelleting machine. The die plate selection is a function of quality & production rate and die speed (rpm) is a function of the feeds to be pelleted. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.3.4 Power Source and Drive System

The power required by the pelletizer for pelleting mainly comes from the extruding deformation area and the extruding formation area.28 The selection of motor for power supply to the pelleting machine depends on the choice of capacity, motor type (2 or 3 phase), voltage, speed, and so on.31 It is found from Gemco (2016)(32) that the electric motor of 2.2 to 7.5 kW is required for the pelleting capacity of up to 80 to 120 kg/h.

2.3.5 Main Frame

The main frame, which provides rigid support and space for the electric motor and pelleting unit, was fabricated by using square MS (mild steel) pipe. The width, length and height of the main frame for the pelleting machine were based on the geometry of the pelleting chamber and motor. A rectangular frame was made (Fig. 4). The provision was given to frame for lateral/vertical adjustment of motor with pelleting unit. Four legs of the frame were also provided with lockable transport to make this developed machine portable. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming.

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2.4 Fabrication techniques

2.4.1 Machining;

Traditional machining processes such as grinding and mixing are commonly employed for fabricating the components of feed making pellet machines, providing precise and accurate results.

2.4.2 Assembly;

The assembly process involves joining the individual components, including motors, bearings, axil, rollers, plate, frames and control systems. Techniques like welding, screwing and adhesive bonding are commonly used to ensure structural integrity and reliability. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.5 Factors that affect pellet quality

2.5.1 Particle Size

Particle size is the factor that causes the least influence on pellet quality (Fahrenholz, 2012). Reducing particle size increases particle surface area relative to its volume, thereby increasing the number of contact sites among particles. As a result, interatomic adhesion forces increase (van der Waals forces, dipole-dipole forces, hydrogen bonding), as well as the capillarity between pellet solid-liquid phases and the penetration of heat and moisture to the centre of the feed particle, consequently reducing heat-treatment time (California Pellet Mill co, 2015; Behnke K.C, 2006). Dozier (2001) suggests that for broiler diets based on corn and soybean meal, the optimal GMD for pellet durability should be between 650 µm and 700 µm. Particles ground larger than 1,000-1,500 µm may produce pellet breaking points (Franke M and Rey A, 2006; Acedo-Rico, J. Mendez and Santoma. G, 2010). On the other hand, the larger surface area of low particle sizes favours heat and moisture transference to the mash inside the conditioner (Lowe R, 2005). However, intense reduction of particle size of feedstuffs may not be beneficial to pellet quality. Fahrenholz (2012) evaluated pelleted feeds formulated with corn with two different particle sizes (298 µm or 462 µm) and did not find any PDI differences. This lack of effect of particle size is possibly due to the fact that the evaluated GMD range was not sufficient to influence pellet quality. However, Wondra et al. (1995) reported a PDI increase of 78.8% to 86.4% when particle size was reduced from 1,000 µm to 400 µm. Therefore, significant reductions in particle size may affect pellet quality. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.5.2 Moisture Addition

Both the water added to the mixer and that added as steam during conditioning aid pellet particle binding. This agglutinating capacity is based on water capillarity properties and surface tension (Froetschner, 2006). Moritz et al. (2002) evaluated the effect of heat treatment (conditioning-pelleting) on feeds containing 927 g or 853 g of moisture per kg of dry matter and obtained 56.5% and 82.2% PDI, demonstrating the beneficial effect of high moisture on pellet quality. Evaluating three levels of water addition to the mixer (0, 25 or 50 g/kg), followed by conditioning for 10 s at 82.2 °C and subsequent pelleting, Moritz et al. (2003) obtained increasing PDI values of 75.6%, 76.9% and 79.6%, respectively. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. The positive effects on pellet quality of the addition of 20 g and 40 g of water per kg of feed in the mixer obtained by Buchanan (2008) are consistent with those results. Abdollahi et al. (2012) verified that the addition of 24 g of moisture/kg of feed conditioned at 60 °C increased the PDI from 56.5% to 67.2%. However, water may act as a lubricant and reduce the friction between pellet die holes and the roller [14, 23-25], negatively affecting pellet durability. This was shown in the study of Colovic et al. (2010), who evaluated different die height to hole diameter ratios (18/6, 36/6, or 48/6 mm), and the highest moisture content of the last treatment (16.2%) annulled the progressive improvement of pellet durability expected with increasing die heights.

2.5.3 Fat Inclusion

High dietary fat content may result in less durable pellets (Briggs, J.L Maier, D.E, Wakins, B.A and Behnke, 1999; Fahrenholz, 2012; Moritz, Cramer, Wilson and Beyer, R.S; Thomas M, Viliet, T and Van der Poel, 1998). Fat reduces the contact of the meal with die-hole walls, facilitating feed passage through the die and thereby reducing feed compaction inside the die holes (Fahrenholz, 2012). The addition of fat before conditioning causes partial encapsulation of feed particles and hinders the penetration of steam, which thus reduces starch gelatinization and weakens capillary adhesion forces (Lowe R, 2005; Fahrenholz, 2012). The amount of added fat should be limited to 5-10 g per kg of feed, if a high percentage of intact pellets is required (Leaver R.H, 2008). Moritz et al. (2002) evaluated two oil addition levels (30 g/kg and 65 g/kg) in broiler diets and observed that PDI was reduced from 81.6% to 62.1% with the highest oil level. Fairfield (2003) and the report of California Pellet Mill Co. (2012) mentioned that adding more than 20 g of fat per kg of feed in the mixer previous to pelleting decreases the PDI of diets based on corn and soybean meal. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.Briggs et al. (1999) also reported that when dietary ether extract increased from 29 g/kg to 75 g/kg, PDI was reduced from 88.8% to 57.2%. The post pellet liquid fat application (PPLA) of supplemental fat is an alternative to maintain the integrity of the pellets. Schramm et al. (2015) evaluated increasing levels of fat inclusion in the mixer (10, 15, 20, 25, 30 and 35 g/kg) and the application of supplemental fat by PPLA method (0, 5, 10, 15, 20 and 25 g/kg) to complete 35 g of fat per kg of feed on PDI. The PPLA increased the PDI from 86%, when all the fat was added in the mixer, to 97% with 25 g of fat per kg of feed added post pellet. The optimal level of PDI was obtained with 23.3 g of fat per kg of feed added post pellet and 11.7 g/kg added in the mixer.

2.5.4 Conditioning

Conditioning is essential to obtain good physical quality of the feed. During conditioning, steam breaks down the structure of starch, resulting in its gelatinization, as well as changes protein tertiary structure. Starch gelatinization combined with protein plasticization allows binding among feed particles, and thereby it is important for the manufacturing of durable pellets (Behnke K, 1994). Abdollahi et al. (2010) evaluated the effect of conditioning temperature on the pellet quality of broiler diets based on corn or sorghum, and observed that when increasing the temperature from 75 °C to 90 °C the PDI improved in both diets. Evaluating different feed retention times in the conditioner, Briggs et al. (1999) reported that increasing retention time from 5 s to 15 s increased pellet durability in 4.5%. Skoch et al. (1981) stated that the addition of moisture using steam improves pellet quality by reducing the proportion of fines and increasing pellet durability. Feed expansion after conditioning may be an alternative to improve pellet quality by adding expansion benefits to pelleting. Exposure to high pressure and temperature for a short time may lead to an improvement in bioavailability of hard to digest feed components (Fancher I, Rollins D and Trimbe B, 1996). When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. In the experiment of Lundblad et al. (2009), when the effect of heat treatment on the pellet quality of corn-based broiler diets by conditioning feed at 82 °C for 30 s was compared to conditioning under the same conditions followed by expansion at 121 °C, a PDI improvement of 81.8% to 92.3% was obtained. Also, Fancher et al. (1996) compared the PDI of broiler and turkey feeds of nine US feed mills before and after the installation of expanders, and reported that it improved from 72% to 89%.

2.6 Conclusion on the literature review

The design and fabrication of feed making pellet machines involve several considerations, including grinding mechanism, material mixing, safety features and ergonomics. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.The traditional machining processes will be employed for fabrication, while advancements in automation, control, pellet quality and energy efficiency continue to progress because of focus. Future research should aim to address challenges related to palletization.

2.7 Modifications

Possible modifications to a feed making pellet machine can be made to improve its performance, efficiency and functionality. These modifications can be carried out individually or in combination, depending on the specific requirements and goals of the pellet machine. Each modification should be carefully evaluated and tested to ensure its effectiveness and compatibility with the overall design. Some of these modifications include; When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.7.1 Real – Time Monitoring Control;

Implementation of sensors and monitoring systems to measure and control various parameters during the palletization process. This can include monitoring pellet quality, motor speed, temperature and moisture levels, allowing for real time adjustments and optimization. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.7.2 Programmable Logic Controller (PLC);

Utilize a PLC control system to automate and optimize the operation of the pellet machine. The PLC can be programmed to control various parameters such as pellet quality and palletization speed to maximize efficiency and ensure consistent quality.

2.7.3 Alternative Power Supply;

Incorporate an alternative power supply system such as solar panels or a battery system to provide electricity for the pellet machine. This enables operation in areas with limited power grid or during power outages, ensuring uninterrupted production. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

2.8 Conclusion on possible modifications that can be made;

By implementing the modifications, the feed making pellet machine can significantly reduce manual labor, increase production efficiency and provide an alternate source of power supply, resulting in improved productivity and overall performance. These modifications can be implemented individually or in combination, depending on the specific requirements and the goals of the pellet machine. Each modification should be carefully evaluated and tested to ensure its effectiveness and compatibility with the overall design. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials for design

Basic requirements for materials selection of the machine components were considered. Even though, the final choice usually involves a compromise, the requirements can be broadly classified as, service, fabrication and economic requirements. Materials for construction were selected based on the availability, durability and purchasing costs. This is done with a view to reducing the overall production cost of the machine.

Table 3.1: Description of material used for machine construction

S/N	**Parts**	**Material used**
1	Die plate	Mild steel
2	Shaft	Plain carbon steel
3	Frame	Mild steel
4	Gearbox	Carbon steel
5	Bearing	High carbon chromium steel
6	Rollers	Mild steel
7	Hopper	Galvanized sheet tin
8	Motor	Electric

Table 3.2: List of consumable equipment accessories

S/N	Material description	Quantity	Remarks
1	Mild steel electrodes,	4	Welding

	Gauge 12		electrodes used for joining fabricated components of the welded joints
2	Hack saw blade, used for cutting light material where necessary	12	Saw blade for Hack saw used to cut mild steel materials
3	Set of drilling bits, it is used to drill holes on fabricated parts	5	-
4	HSS cutting tool	1	Used to cut workpieces on a lathe
5	M17 short (gauge 8.8)	15	Nuts and bolts are employed to fasten joint fabricated parts
6	M17 long (gauge 8.8)	5	-

The following material properties were critically looked into in the design;

I. **Mechanical Strength**: This includes the toughness and corrosion resistance characteristics of the materials to be used (i.e., this should be considered depending on the service requirement).

II. **Cost**: The cost of any material involves; raw materials, fabrication, and installation costs, in terms of replacements due to failure. If the cost is not considered, the expenses while undergoing repair or replacement should be considered which in absence of that may lead to economic damage and production losses.

III. **Service Requirements**: These include the dimensional stability, strength, and toughness, etc.

IV. **Design Frame**: In selection of materials, design is closely related to the strength and ductility. However, there are several cases in which the search for a substitute material lead to feasible design modification which should be much more advantages than a change in alloy composition.

V. **Availability**: If a material is not available, irrespective of the advantages of the material, it is not reasonable to base a design on it. This involves availability of material at an appropriate cost and availability in desired form.

VI. **Fabricability**: There is a close relationship between fabricability and availability. One of the most challenging tasks of an engineer is proper selection of the material for a particular job. An engineer must be in position to choose the optimum combination of properties in a material at the lowest possible cost without compromising the quality (i.e., the material that will be easy to fabricate should be selected).

VII. **Ductility**: This related to strength, considerable ductility is generally obtained at a sacrifice of strengths during cold working of metals. However, the more ductility obtainable without great loss in strength, the better, at the same time, appreciable ductility is required for fabrication by rolling and mechanical working processes. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

3.1.2 Equipment and Tools

The equipment and tools used for the study are: When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

3.1.2.1 Design Tools

Computer softwares were used to aid the design of the fixed flat die poultry feed pelletising machine and to draw the machine components. The design and drawing softwares are: Microsoft excel (2012) and Inventor 2015 Autodesk software (3D Modeling)

3.1.2.2 Fabrication Equipment

Critical fabrication equipment used in the construction of the machine are shown in Table 3.3.

Table 3.3: Critical equipment used for the vehicle fabrication

S/N	Equipments	Specification/Use
1	Flextec 450, Lincoln Weld machine	**Input Voltage:** 380/460/575/3/50/60

		**Input Current at Rated Output:** 3 Ph / 60% Duty Cycle: 37/27/22A **Rated Output:** 450A/38V/60% **Output Range:** 10 - 500 Amps **Weight/Dimensions (H * W * D):** 125 lbs. (56.8 Kg) 18.8 * 14 * 26.5 in. (477 * 356 * 673 mm).
2	Abrasive cutting/ grinding machine 	**220V Rated Input Power:** 1400W **Disc Diameter:** 115mm **Rated Voltage**: 220V **No-Load Speed:** 9000rpm **Frequency**: 50HZ **Disc(Wheel) Type:** Grinding/ cutting Disc **Dimensions:** 44*15*13cm (inner box)
3	Pillar drilling 	**Max. Drilling Dia. (mm):** 25 mm **type:** Pillar Drilling Machine **Range of Spindle Speed (r.p.m)**: 96 - 2600 r.p.m **CNC or Not:** Normal **Drilling Speed:** 8 **Brand Name:** BHAVYA **Model Number:** BMT-25 **Weight (KG)**: 470 KG **Power:** 745

4	Center lathe machine 	**Max. Length of Workpiece (mm):** 520mm **Range of Spindle Speed(r.p.m):** 20 - 2000 **Machining Capacity:** Medium Duty **Spindle Bore(mm):** 20mm **Max. Turned Length (mm):** 520mm **Type:** Horizontal **Spindle Motor Power(kW):** 0.55 **Brand Name:** SYNTOP **Model Number:** BV20 Voltage: **Dimension (L*W*H):**1200*500*550mm **Weight (KG):**110 KG **Max. Swing Diameter (mm):** 220mm **Swing Over Cross Slide:** 220mm **Spindle Bore**: 20mm **Spindle Taper:**MT3 **cross slide travel:** 70mm **Tailstock quill taper:** MT2 **Tailstock quill travel:** 50mm **Range of metric threads**: 0.4-3mm **Range of Inch threads:**8-32 T.P.I

3.3 Design considerations

In order to make effective an acceptable design, the question of workability, durability and reliability of the components constituting the paint mixing machine must be given due consideration. The workability of the machine is a question of providing components, which perform in accordance with the design specifications and integrating these components into an operational feasible unit. Durability ensures that the machine will continue to operate during its design life without material or component failure, while reliability ensures that the machine performs according to the design requirements. Summarily, In the design of the slicing machine, the following factors were considered: When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

I. Stress induced on the shaft when subjected to torsion
II. The strength and rigidity of the shaft when transmitting power under various operating and loading conditions
III. The amount of power to be transmitted to the shaft through the electric motor
IV. The reliability of the machine, durability, and its safety during use
V. The type of manufacturing processes to be employed at low cost of production, Versatility, portability, and ease of maintenance of the machine.

3.4 Design of machine components

The components of a feed making pellet machine are as follows;

I. Feeding hoppers

II. Pelletizing chambers

III. Die and Rollers

IV. Motor and Gearbox

3.4.1 Feeding hoppers

Here, the machine is filled with raw materials like grains, grasses, or other feed ingredients.

3.4.2 Pelletizing chamber

Here, the raw materials are crushed and formed into pellets in the centre of the pellet mill. There are rollers and a die inside the pelletizing chamber. Pellets are formed by forcing raw materials through tiny holes in the die under pressure.

3.4.3 Die and Rollers

One important factor in determining the size and form of the pellets is the die. It has tiny holes that allow pressure to be applied to extrude the raw materials. The raw materials are forced through the holes in the die by the rollers, which also shape them into pellets.

3.4.4 Designing of the Rollers

Roller Design was done considering Roller and Die Surface as frictional Wheel. Roller is rotated by power from motor which is transmitted with the help of a transmission shaft which is keyed to the roller, as the roller rotates on the die plate. There will be slip in between the die surface and roller surface. The teeth on wheels of roller act to pick up feed When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. materials from the hopper and compress into the die holes and also to prevent slippage when in contact with wheel of roller. For safe limits the diameter of roller was taken 90 mm. Shaft diameter was taken as 40 mm . The ball bearing selected was 68mm When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

3.4.5 Steps in designing the rollers

i. A steel pipe of 90mm diameter was cut into two halves of equal length, 60cm each.

Plate 3.1: Steel Pipe

ii. A center lathe machine was used to face the ends of the workpieces

iii. Bearings of 68mm was installed into the workpieces

Plate 3.2: Rollers

iv. The shaft was connected thereby forming the rollers

3.4.6 Designing of the Die plate

The die plate is made of stainless steel of 25mm thickness with 250 drilled holes. The machining processes used to design the die plate were;

i. Cutting
ii. Shaping
iii. Facing
iv. drilling

3.4.7 Steps in designing of the Die plate;

I. A 30cm x 30cm square shape was marked on a 25mm thickness steel

Plate 3.3: Cutting of the 25mm steel

II. An angle grinder cutting machine was used for cutting.

Plate 3.4: Cutting of the die plate

III. The cutting machine was then used to shape the steel plate edges to enable use of the lathe machine because the desired shape is a round circular shape.

Plate 3.5: Cutting of the die plate

IV. The lathe machine was then used to shape the plate, giving the plate a round circular shape, a 40mm hole was then drilled on the middle of the plate. Shaping and Facing machining processes were applied here.

Plate 3.6: Shaping using the lathe machine

V. After shaping the steel plate, the holes were drilled

Plate 3.7: Drilling of the die plate

3.4.8 Designing the Pelleting Chamber

After the material is properly mixed it will introduce in pellet chamber. This is where mixing and extruding of feeds was performed prior to being pushed through by the pellet rolls into the holes of the die plate. This part was made from mild steel (MS) plate with dimensions of 220 diameter x 33 cm high in order to withstand the rigorous force created by the rotating die plate and pellet rolls.

3.4.9 Steps in Designing the Pelleting Chamber

A steel cylinder of 220 diameter and 33cm in length was cut in two halves using the lathe machine, one halve was 15cm and the other 18cm

A lathe machine was then used to remove excess pieces from the inner diameter of both halves of the cylinder to enable the die plate rest in one half and be covered by the other half of cylinder, forming the pelleting chamber When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

Plate 3.8: One half of the pelleting Chamber

Plate 3.9: Full pelleting chamber

3.4.10 Motor and Gearbox

The motor provides the power needed to drive the pelletizing process, while the gearbox helps regulate the speed and torque of the machine. The motor used in this project is 5 horsepower motor of single phase, the gearbox is to reduce the speed of the motor to ratio 1:4, that is the motor needs to make 4 input turns to give out 1 output turn from the gearbox

3.5 Design Analysis and Calculations

This covers the design of the major components required for effective operation of the machine. The following requirements were met through analysis and calculations.

i. The thickness of the required components.
ii. The specification of the right size of materials based on results from calculation.
iii. The possible loads applied, the bending moment on shaft.
iv. Power requirement of electric motor etc

3.5.2. Pelletizing Chamber (Barrel)

The surface area (Sb) and volume (Vb) are given as:

$$S_h = \pi D_0 \left[\frac{D_0}{2} + L\right]$$

$$V_b = \pi \frac{D_i^{\ 2}}{4} L$$

Where, Do = outer diameter, Di = inner diameter and L = length.

3.5.3. Total Power Required for Pelletizing Process (Pt)

The total power required for the pelletizing process is given as:

$$P_t = \frac{(W_c + F_{at} + W_p\ )}{1000}$$

Where, Wc = weight of shaft, screw conveyor and cutting mechanism, Fat = axial thrust by the screw conveyor, Wp = weight of pulley and vp = peripheral velocity of the rotating mechanisms.

3.5.4 Shaft design

The design of power transmitting shaft basically consists of the determination of the correct shaft diameter to ensure satisfactory strength and rigidity, during its operation under various loading and working conditions. Shafts are usually circular in cross section and may either be hollow or solid. For the rotating shaft, pure torsion was assumed and maximum shear stress due to torsion was employed and the angle of twist were considered. The values of which was gotten from relevant tables and chart. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

The following are considered during shaft design:

i. The diameter of the shaft

ii. Length of shaft.

iii. Reactions on bearings resting on shaft

iv. Size of bearings.

v. Bending and Torsional Moments.

The shaft was designed to carry the weight of the roller. It is subjected to bending and twisting moments from the contact between the roller and the die. The shaft diameter was designed on the basis of strength using equation. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

$$T_e = \frac{1}{16} r d^3$$

Where, T = equivalent twisting moment, N-m from Design data book by B.D.Shiwalkar [3] we have ,

$$T_e = \sqrt{(K_m \times M)^2 + \left(K_i^{\times} T\right)^2}$$

Km = Shock and Fatigue factor for bending, Kt = Shock and Fatigue factor for torsion, M = Bending moment, N-m T = Torque acting on the shaft, N-m Therefore torque, T transmitted by the shaft is given by

$$T = \frac{P \times 60}{2\pi N}$$

P = power of electric motor (kW) N = Speed of electric motor (rpm) On performing subsequent calculation diameter of shaft was taken to be 30mm (about 1.18 in).

For the rotating shaft, pure torsion is assumed. Hence, the maximum shear stress due to torsion and the angle of twist are considered.

$$P = Tw = \frac{2\pi NT}{60}$$

$$T = \frac{60P}{2\pi N}$$

T = 153.3 Nm

Diameter of shaft = 0.025

Active lenght of shaft = 0.34

Maximum stress due to torsion is $\theta = \frac{TL}{GJ}$

$$\theta = 0.92^0$$

3.5.5 Bearing housing

This component is designed to encase the individual bearing used in this machine. It encloses the outer diameter of the bearing in a tight fit so as to prevent its free movement with the aid of attached flange, it is fixed with bolts to the flange.

3.5.5.1 Bearings

Ball Bearings of bore 30mm were selected to suit the shaft used in the project.

Ball bearings are mainly used in industrial designs and are readily available.

3.5.5.2. Bearing Selection for Shaft

The equivalent dynamic load (P), on the system, the nominal rating life of the bearing (L), the full bearing life in working hours (Lh) and reliability (R) were calculated as:

P = [X .V. Fr] + [Y. Fa]

$L = \left[\frac{C}{P}\right]^k \times 10^6$ revolutions

$L = \frac{5 \times L}{60\, N_2}$ [hours]

[Note:If Lh > 4000 hours, the bearing is selected]

$$Log_e \left[\frac{1}{R}\right] = \left[\frac{L}{a^*}\right]^{b^*}$$

Where, Fr = radial load, Fa = axial load, C= basic dynamic load rating, k = life exponent for ball bearing, N2 = shaft speed, Y= axial load factor, X= radial load factor, V= bearing type, a∗ and b∗ are constants. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

3.5.6. Design of the Frames and Bolts

The frame and bolts designs were obtained based on the consideration to the shear stress on the machine as:

$$d_b = \sqrt{\frac{4 \times W_{t.max}}{\pi S_e}}$$

Where, db = bolt diameter, Wt.max = assumed maximum total weight of the machine/loads and Se = allowable endurance stress of mild steel.

3.5.7 Die Design

The effective die area (Ac), die output area (Ao) and axial thrust (Fat) required to extrude the feed mix were given as:

$$Ac = \frac{\pi}{4}\left(d_d^2 - d_s^2\right)$$

$$Ac = \frac{\pi}{4} \times d_h^2 \times N_h$$

$$F_{at} = P_e \times \left(A_c - A_0\right)$$

3.5.8 Speed reduction mechanism

$$Nsh = Nm \times \frac{1}{r} = 1440 \times \frac{1}{4} = 360rpm$$

Where Nm = speed of motor = 1440rpm, r = speed ratio =$\frac{1}{4}$

$$= \frac{2\pi \times 360 \times 32.7}{-60} = 1232.76w$$

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Results

4.1.1 Development of the conceptual design

A fixed flat die poultry feed pelletising machine as been successfully designed. The developed machine has the following main component; feed hopper, screw shaft, barrel, choke mechanism, oil tray, prime mover and main frame. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

Figure 4.1 shows the pictorial view of the machine.

Plate 4.1: pictorial view of the machine

Figure 4.1: Isometric and orthographic view of the Pelletising machine

4.1.2 Technical characteristics of the fixed flat die poultry pelletising machine

The technical characteristics of the pelletising machine fabricated are shown in Table 4.1.

Table 4.1: Technical characteristics of the Pelletising machine

S/N	**Description of parts**	**Values calculated**	**Units used**
1	Length of Pelleting Chamber	330	mm
2	5mm thickness of angular bar	1100 310	mm
3	Die plate	25	mm
4	Rollers of 60mm each	190	mm
5	Shaft of diameter 40mm	460	mm

6	Young modulus of elasticity of shaft material	207×10^9	N/m^2
7	Factor of safety	4	-
8	Distance between two bearings	10	mm
9	Torque on shaft or torsional moment	2137.13	Nm
10	Electric motor power or transmitted power	5	hp
11	Gear ratio	1:4	-
12	Weld size	10	mm
13	Electric motor efficiency	0.79	-

Table 4.2: Materials for construction of the machine and it's specifications

S/N	Material description	Quantity	Remarks
1	5mm angle bar	-	Use for the construction of the door frame
2	40mm diameter shaft	-	Used for the construction of the shaft
3	10mm steel plate	2	Used for holding the gearbox and pelleting chamber together
4	θ 50mm cylinder	-	Used for housing the bearings the shaft passes through
5	10mm steel pipe	2	Used as the rollers

6	68mm bearing	2	Used in the rollers
7	M17 short bolt (gauge 8.8)	15	Nuts and bolts are employed to fasten joint
8	M17 short bolt (gauge 8.8)	5	
9	5hp gear motor	1	Speed reducer

4.1.4 Machine assembly, description and working principles

4.1.4.1 Machine assembly

Figure 4.2 shows the assembled Pelletising machine. The detailed drawings of pelleting machine are shown in the appendix. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

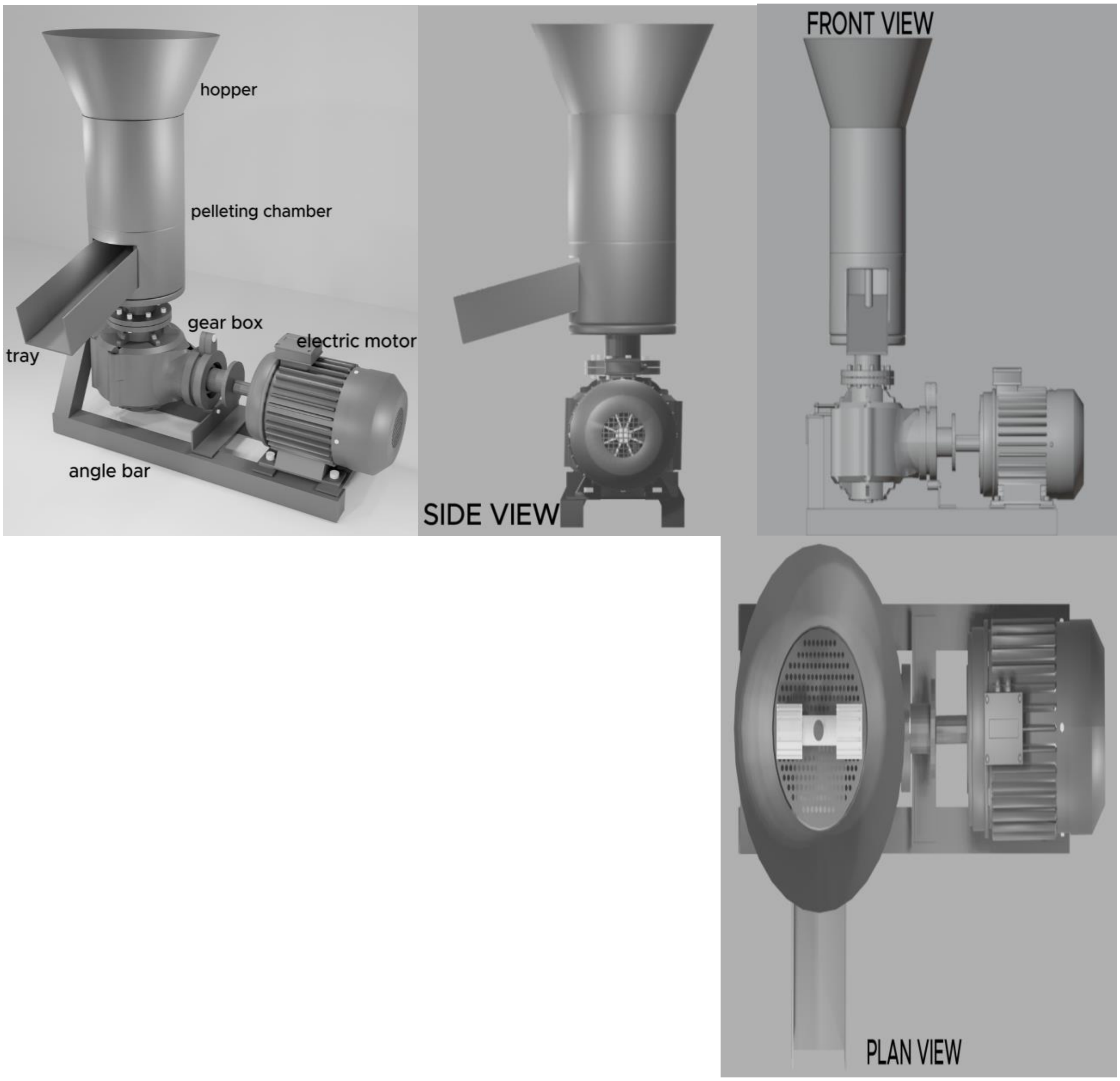

Fig 4.2

4.1.4.2 Description of the Machine

The machine consists of different parts such as: the hopper; the frame; the pelleting chamber, the electric motor, the gearbox or speed reducer, the shaft, the bearings. The Pelletising machine consists of: the hopper shaped as a truncated frustum of a pyramid, with top and bottom having rectangular forms, is mounted on the chamber; the framework of outline dimension 1100mm

When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.long x 800mm high x 310mm wide; bolted to the foundation platform; a gearbox of speed ratio 1:4; a rigid flange coupling between the gearbox and the motor; a shaft of length 460mm and diameter 40mm.

4.1.4.3 Working principles of the Machine

The feed is fed into the hopper, and finally lays on the die plate, as the shaft roates inside the cylindrical barrel, the rollers roate too, resulting to a translational and rotational motion. The rollers roll on the die plate, forcing the feed to pass through the 5mm holes on the die plate, forming the pellets, the pellets then flow out from an opening on the pelleting chamber. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the

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Table 4.3: Bill of engineering measurement and evaluation (BEME)

S/N	Components	Material description	Amout
1	Framework	1100 ×310 angular bar	#30,000

2	Shaft	460 × 40mm carbon steel	#35,000
3	Bearings	32310 series tapered roller bearing	#15,000
4	E lectric motor	5hp electric motor	#120,000
5	Installations accessories	Bolts and nuts	#5000
6	Chamber	10mm thick steel cylinder	#20,000
7	Die plate	25mm steel plate	#20,000
8	Gearbox	-	#28,000
9	Miscellaneous	Oxygen gas, Transportation, machining costs, documentation and printing, welding electrodes, cutting discs, cutting tool(carbide tool)	#50,000
10	Total Manufacturing cost	-	#323,000

CHAPTER 5

CONCLUSION AND RECOMMENDATION

Conclusion

The main features of the machine, s, bearing housing, the pelleting chamber. The experimental test was done by mixing various ingredients thoroughly into paste form using water as binder and was then feed into the hopper. The machine was then set to gyration. This extended through the extending holes of the die plate and was cut to desired sizes by the cutting mechanism. Proportionate mixture of the water and the ingredients to avoid watery compaction. It was also discovered that Inconsistent mixture of the ingredients may lead to a sticky product and as such the pelletized feed breaks before getting the desired sizes. That is with excess water it turns sticky and with less water the extended feed become too hard. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

The poultry feed pellet machine was fully developed putting much factors together. The result obtained showed that the machine's capacity is 5kg/hr and the feed were well pelletized. The production of the machine will aid meet the rising needs of poultry and fish production as a means of boosting the food production capacity. The machine was produced in an economical method as the cost analysis of the machine is cheap. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce. When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.

Recommendation

The following are recommended to further improve the design and operation of the pellet mill:

i. The feed hopper should be modified to minimize the spillage of mixed feeds due to the force created by the rotating pellet rolls.

ii. A stopper or vertical lid should be provided on the opening of the discharge chute to better manage the pellets that come out of it.

iii. A pellet screener that would separate pellets from fines that come out of the die plate and a separate discharge chute for these fines to allow them to be pelletized again should be provided.

iv. Rollers should be installed on each leg of the frame to allow easy transfer every time the machine is used.

v. A cover on the electric motor should be provided to minimize spillage of feeds that might clog the rotor part of the machine causing interference in its operation When considering the pellet mill, several critical aspects must be examined to achieve optimal machine efficiency. Maximum efficiency is defined as the ideal balance of producing the highest possible pellet quality, at the greatest production capacity, while minimizing energy consumption. To reach this level of efficiency, it is essential to have the appropriate pellet die speed and the correct ratio of the die working face area to the power being utilized, tailored for each specific application. 1.2 Statement of the Problem The government's increasing focus on agriculture has attracted many young individuals to pursue farming, with a significant number engaging in fish and poultry farming. Consequently, the demand for animal feeds has surged, placing considerable pressure on fish and poultry feed production companies and driving up feed costs. This situation necessitates urgent research intervention to develop an improved pelletizing machine system to address these challenges, helping to rescue Nigeria from its economic downturn and create new job opportunities for the workforce.