Modification and Evaluation of the Performance of Agricultural Manual Mixing Machine

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***Abstract*-The modification of the manually operated multi-purpose mixing machine was under taken with the intention of providing a simple and effective solution to the problem of hand mixing of either chemicals with agricultural materials or different agricultural materials together. The developed mixing machine is made up principally of hopper through which the materials are introduced into the machine for mixing operation. The performance of the machine was evaluated based on its effective capacity, damage grains and scatter losses. Results showed that both damage grains and scatter losses are zero, with moderate effective capacity of 240 kg per hour. The cost was reduced by about 65% compared with the existing motorized mixers, thus making it potentially more economical and easier to afford by peasant farmers and food processors.**

***Key words:* Agricultural materials, Mixing operation, Mixing machine,Performance, Manual.**

I. INTRODUCTION

The use of hand to mix seeds with chemicals as well as crushed poultry feed by the traditional agricultural sector as characterized by subsistence farming was perhaps the first form of mixing operation. This method was subsequently developed by the use of manually operated machine after the advent of industrial revolution in Great Britain, also the universal demand for poultry feed due to its use in domestic poultry as a machinery for food production as well as our small-scale industries in the country are in dire need of a highly nutritious poultry feed for their birds to increase production output and the danger associated with farmers having direct contact with toxic chemicals.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 rather than mere assembling activities such an effort would reduce importation of machines, spare parts and components that can be produced locally [1].

Agriculture is the world's oldest and perhaps the largest industry that plays a significant role in the existence of human. It is the only industry in the world that caters for all living things. The role of the industry is better appreciated when it is realised that the three basic needs of man which are clothing, food and shelter are met through agriculture. As it caters for all, it is also an area in which every body shows some interest either directly by being a farmer and producer or indirectly as a consumer who through the purchase of agricultural product make more money available to the farmer.

Despite the long years of agricultural practice with expected experiences, researches are still being undertaken aimed at reducing the drudgery and resources input in production in order to increase output levels to meet the ever rising population. Agriculture as a multi-disciplinary industry involve a number of professionals all working as a team with the primary objective of making food and fibre available and improving the economic situation of the principal actor- the farmer.

Nigeria is one of the blessed countries that produce varieties of grains cutting across the different ecological zones of the country [1]. Over the year's different mechanical means of mixing agricultural materials with chemical or additives were introduced in Nigeria through importation which includes power mixers of various makes and models.

However, various tests conducted at the Institute for Agricultural Research (IAR) Ahmadu Bello University, Zaria reveals various defects in the performance of these machines, this includes seeds loses of unacceptable levels, while seeds damages could be upto 5% [2]. According to [3] the power an average man can generate is 83 w, this means that the machine can be operated conveniently by human muscles.

II. LITERATURE REVIEW

Seed dressing as well as feed production for livestock, poultry or aquatic life involves a range of activities, which include grinding, mixing, pelleting and drying operations. [4] gave a summary of the different types of machinery needed for the production of various types of feeds and they include grinders, elevators and conveyors, mixers, extruders, cooker, driers, fat sprayers and steam boilers.

The mixing operation in particular, is of great importance, since it is the means through which two or more ingredients that form the feed are interspersed in space with one another for the purpose of achieving a homogenous mixture capable of meeting the nutritional requirements of the target livestock,

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poultry or aquatic life being raised. Essentially, 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. 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 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 wide variety of mixers are available for use in mixing components, the selection of which depends mainly on the phase or phases the components exists such as solid, liquid or gaseous phases. Some commonly used solid mixers as discussed by [5] includes: Tumbler mixers**,** Horizontal trough mixers, Vertical screw mixers etc. These are quite quick and efficient particularly in mixing small quantities of additives into large masses of materials. [5] Observed that regardless of the type of mixer, the ultimate aim of using a mixing device is to achieve a uniform distribution of the components by means of flow, which is generated by mechanical means. In most developing countries including Nigeria, a major common problem facing farmers raising livestock, poultry and/ or aquatic life is the lack of access to proper feeds that can meet the nutritional requirements of their flocks at the right time and in the right quality and price. [6] observed that the rate of poultry production in Nigeria does not commensurate with human population growth and demand. He therefore, opined that the major constraint is the high cost of feeds in the market. Similarly, [7] cited that protein from animal sources contribute about 17% of the total protein consumption in the average Nigerian diet compared to a contribution of approximately 68% of the total protein consumed in New Zealand, 71% in USA, 67% in Denmark and 60% in the UK.

The reason for the low level intake of animal product in African countries he argued is due, partly, to the low population of cattle in some regions in relation to human population and requirements, but primarily due to low level of animal productivity in terms of slow growth, long calving intervals, slow reproductive cycle and low milk yield all occasioned by poor quality and or insufficient feeds. [8], [9], [10], [11] and many other researchers have indicated the feasibility of the utilization of various forms of farm and agro-industrial wastes and by-products in the formulation of complete feeds for livestock, poultry and aquatic life.

Although the major essential raw materials required for the formulation of complete feeds from the results of such researches are within easy reach of the farmers and at low cost, the major limiting factor to taking the full advantages offered by the results of such researches has been the lack of available appropriate equipment to process the identified raw materials into the required feeds.

The objective of this paper was, therefore, to fabricate a multi-purpose industrial mixer at a cheaper and more affordable prices to our farmers, The development of the multi-purpose mixing machine will provide an affordable, safe and drudgery free means of mixing agricultural materials with one another, with chemicals and also poultry fed mixing especially by local farmers in a developing countries like Nigeria,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 mixing 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.

III. MATERIALS AND METHOD

A. Study Area

The Fabrication and evaluation of the performance of the machine were conducted at College of Agriculture, Hassan Usman Katsina Polytechnic, site is approximately located at 13° 01′ N 7° 41′ E and 619m above sea level in the Sudan Savannah ecological zones of Nigeria [12].

B. Materials

The materials for the construction of the machine are to be sourced locally so as to be cheap to own and use by the stock raisers. This should serve as a guide in material selection. Also the materials are chosen on the basis of their availability, suitability, economy, viability in service among other considerations [13].

C. Description of the Machine

The mixing machine comprises of hopper, handle, shaft, bearings, mixing unit and supporting frame.

a) Hopper

The hopper assembly was to introduce agricultural materials into the mixing cylinder. It was inclined at 30° to the horizontal so that there will be free flow into the cylinder. The hopper was constructed from 16-gauge (1.6mm) metal sheet.

It is dimensioned 270 x 520 mm at the inlet and 130 x 370 mm at the cylinder side. The height of the hopper is 460 mm.

b) Frame

The frame was constructed using a 40 x 40 mm angle iron for rigidity and stability. The frame structure was dimensioned 1340 mm long, 700 mm high and 400 mm wide. The mixing handle and housing for mixing cylinder were bolted on the frame. All the static and dynamic stresses resulting from eccentric loading and torsion was considered in the design.

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c) Mixing unit

The mixing unit carried out the actual mixing operation. It comprise of rotating fingers. The cylinder is 140 mm diameter with length of 320 mm. 6 numbers of 20 x 20 mm are welded equi-distant on the rotating shaft of 600mm diameter and 150 mm long. The unit has two openings of which one is for the inlet channel and the other for discharge, 70 and 5mm diameter at inlet and discharge ends respectively.

d) Handle

The handle was constructed using 250 mm long 8 mm diameter iron, used to turn the rotating fingers. It can be turned in either direction (clockwise and anti-clockwise). It is designed to withstand both torsional and bending stresses.

e) *Bearing*

The bearing housing is the part of the machine that supports the shaft; it also positions the shaft for effective rotation. The radial loading, rating life, axial loading, equivalent load and basic load rating were taken into consideration in the selection of the suitable bearing.

f) Bolt and Nut selection

The force and stress analysis were not considered during bolt and nut selection, this is because the bolt was not carrying any weight. A bolt of diameter of 5mm was selected for all attachments.

D. Test Procedure

In order to test the manual agricultural mixer, the machine was subjected to performance tests using same quantity of millet, sorghum and maize. The operation of the machine is simple. The grains is poured into the hopper to the mixing unit, after the top cover has being opened. After closing the top cover, the power shaft is then rotated manually in any direction using the handle. The rotation of fingers there by force all the materials to move and mix thoroughly. The mixed material is collected through the discharge outlet. Three readings were taken and the average was calculated. The parameters determined are the effective capacity, percentage scatter loss and damage grains.

Damage grain

$$dg = \frac{G}{100} X\ 100 \ldots\ldots\ldots Equation\ 1$$

Where: dg =damage grains, %

G = weight of visually damage grains isolated in 100 grams of mixed sample.

Scatter loss

$$Ls = \frac{E}{TG} X\ 100 \ldots\ldots\ldots Equation\ 2$$

Where: Ls = Scatter loss, %

E = weight of scattered grain collected per unit of time, kg

TG = Total grain input per unit of time, kg.

A stop watch (precista max 60) was used in determining the mixing time, while a weighing balance scale to the nearest 0.001 g accuracy was used in determining the weight of all the samples.

IV. RESULTS AND DISCUSSION

The following measurements were taken before and after the mixing operation.

i. Weight of grain = 20.0 kg
ii. Weight of loss grain = 0.0 kg
iii. Mixing time = 5 minutes
iv. Damage gains = 0.0 kg

Determination of effective capacity.

20.0 kg of grain mixed in 5 minutes

5 minutes = 20.0 kg

1 minute= $\frac{20.0\ kg}{5\ minutes} = 4.0$ kg

60 minutes = 4.0 kg x 60 minutes

=240 kg / hour.

Effective capacity = 240 kg /hour.

The improved version led to significant decrease in the percentage of both damage and loss grain which is zero, making the manual mixer more suitable for the mixing of seeds. More importantly the production cost is lower. Also the replacement of the 8-6 HP diesel engine with a more simpler, smaller and more cost effective human muscles and the absence of the heavy flywheel in the improved version.

V. CONCLUSION

The machine was designed and fabricated to provide efficient mixing operation of agricultural materials with chemicals for storage or planting purposes as well as mixing of feed ingredients meant for livestock and poultry feeding. The design was made to ensure proper safety of the farmers.

The mode of operation of the manual mixer is simple to be understood by the farmers and its maintenance is easy. With this improved version it is hoped that the machine would be better patronized especially by potential entrepreneurs for mass production and commercialization.

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