PROTOTYPE MACHINE TO MIX AND ADDING ANIMAL FEED

El-Shabrawy T. H.*, Salim R. G.** and Shetewy M. A.***

ABSTRACT
Small animal farms are currently adding and mixing of feed materials manually, which may cause wasting the amount of it. Transfer and delivery of the mixed animal feed to feedlots may be causes the difficulty of achieving distributed recommended ratios of feed mixing operation. Some of the interactions between the components may occur after leaving period which may cause rot and damage to the feed materials. Grinded (concentrated) animal feed is difficult to add directly in the form of powder separately. Preferably mixed them with roughage materials and adding feed materials blended automatically. To obtain the mentioned aim, locally manufactured machine achieved mixing and adding at the same time with recommended ratios obtaining a little bit losses of feed materials. To performance and evaluation of new machine, experimented in the animal farm at the three different tested factors. Four forward speeds \( (F_{s1} = 1.2) \) \& \( (F_{s2} = 2.2) \) \& \( (F_{s3} = 3.1) \) \& \( (F_{s4} = 4.2) \) \( \text{km/h}, \) Four opening hopper gate ratios \( (\text{roughage feed material gate : concentrated feed material gate}) \ (G_1 = 1:1) \) \& \( (G_2 = 1:2) \) \& \( (G_3 = 1:3) \) \& \( (G_4 = 1:4) \) and three Revolution ratios \( (\text{Mixing auger revolution : stirring shaft revolution}) \ (R_1 = 1:1) \) \& \( (R_2 = 1:2) \) \& \( (R_3 = 1:3) \). The animal feed adding rate as kg to one longitudinal meter of feedlot (kg/m), mixing quality of animal feed materials were measured. The obtained results showed that, the new machine works properly at lowest forward speed \( (F_{s1} = 1.2 \text{ km/h}) \) with deferent other treatments under study, but the optimal quantity of feed additives by machine 16 kg/m achieved with \( (R_2 = 1:2) \), also new machine had highest efficiency of animal feed mixing process quality with all treatments under study specially with \( (G_3 = 1:3) \)

INTRODUCTION
The supplemental fodder was designed to provide a given level of animal food in the herd, Huston (2000). Much of the variation in response to supplement programs has been attributed for variation

*** Assoc. Prof and chairman of Agric. Structures and environmental control Eng. Dept. Fac. of Agric., Al-Azhar Univ.
in supplement intake by individual animals. Wand (2014), reported that silages, hay and grain are fed at the same time. Stationary and mobile mixers are available, new mixers use a batch-mixing approach. They require specialized feeding arrangements (drive-through feeders for mobile units, conveyor belts or wagons for stationary units). Daily time requirements include loading, mixing and dispensing, there large-batch mixers, which can grind dry hay into concentrate ratios. It is run off by PTO power and including dispensing auger. These allow bins to be filled at one or more locations. Daily time requirements include loading, mixing and dispensing. Pulsipher (2000) said that animal meals typically are combinations of dry ingredients mixed together with no further processing. Meals are a common form of range mineral supplements is difficult to bind together, and the loose form encourages consumption. Bowman and Sowell (1997) found that, 5% of hand-fed animals failed to consume any supplement, while 19% of self-fed animals did not consume any supplement. Galyean et al. (1992) confirmed that, portable auger system may be needed to move feedstuffs to a storage destination. Feed delivery vehicles also vary in capacity and number of separate storage compartments on a single trailer. Feedstuff delivery vehicles must be able to navigate to and from on farm delivery sites easily. Narrow gates, poor road surface, and driving obstructions can limit on farm feed receiving capabilities. Comerford et al. (2013), explain the amount of beef feed vary depending on several factors whether animal breed to produce meat and animal age, large expansions in beef farms reached 50,000 head contributed to circulate feed lots and the use of horizontal and vertical feed mixers. But, Grover and Mishra (1996) mentioned the important forces that influence the compaction of biomass play their role mostly in the compression zone. The compaction occurs when the biomass is fed into a screw extruder and force is applied due to the restriction in the form of a die. Nader et al. (2000) studied the utilization of rice straw as roughage material to feed cattle. They reported that animal feeding constitutes the largest current off-field use for rice straw. Rice straw is a low-value feed, but protein content is enhanced by rapid harvest of straw to reduce volatile loss of nitrogen that occurs during extended exposure in
the field. The farmer can vary the quality of the feed to each stall, placing high quality feed in some, and lower quality feed in others Jtaer (2007). This variation enables the high yielding cows to be given higher quality food whilst cheaper food can be given to those cows nearing the end of their lactation cycle, and producing less milk – obviously a more cost effective feeding system, while maximizing the potential for milk production. Sharma and Aggar-Wal (1987) gave a summary of the different types of machinery needed for livestock, poultry production of various types of feeds and they included grinders, feed mixers, silos elevators, automatic water pots. The aim of this study is to construct and performance evaluate a simple prototype manufactured in private workshop. To mix animal feed materials (roughage and concentrated materials) in prescribed ratios and adding it to the animals in the quantities recommended.

MATERIALS AND METHODS
Investigate the prototype has been manufactured from cheap and simple row materials taken into consideration during manufacturing process and has two options, trailed by tractor or driving with two arms by labor as needed. The experiments were conducted in the jemeza researches station in Gharbia governorate.

Important points have been taken into consideration during theoretical calculations and design the prototype such as:
- Reduce animal feed waste and scatter (as a result of the animal inflatable).
- Quality of the animal feed mixing process by machine mixing auger.
- Its preferably each meal must addition to animal in two or three stages to ensure ruminating process happens, this due to optimize nutrients of animal feed materials and drinking a lot amount of water, resulting in increased animal production of meat and milk.

The manufactured prototype
The prototype consists of multiple parts help in mixing and adding feed materials in addition to the group of transmission gears with two ground wheels and link of tractor suspension as shown in figures (1 A and B).

Source of power
A 60 HP Nasr tractor was used in the experiments, but all moving parts of prototype take its motion from ground wheel.
Fig. (1A): schematic diagram of parts for investigated prototype

Fig. (1B): The prototype during experiments
The prototype mechanical parts can be divided into three main groups as follow:

(1) New prototype feeding parts:
The prototype contains a hopper as shown in figure (2A) with sloping sides. It is divided into two sectors filled each one by different type of animal feed materials (roughage and concentrated materials). Each sector have feed gate and contain rotary stirring shaft as shown in figure (2B) help to flowing of feed towards feed gate then to mixing auger at the bottom of feed hopper, the control amount of feeding achieved through two sliding scaling gate at the bottom of each sector of the hopper.

![Fig. (2 A and B): Main prototype feeding parts](image)

(2) Animal feed mixing and adding mechanism
Mixing auger was attached in the bottom of two feeding gates and hopper with geometric dimensions as shown in figure (3) based on the theory of studies, take its movement from ground wheel, with the aim to give the required amount of mixing animal feed materials per longitudinal distance. Steering hose attached auger slot to direct animal feed mixing materials into animal feedlots.

(3) Prototype transmission system
The moving parts of the prototype (stirring shaft and mixing auger) take its motion from ground wheel by groups of transmission gears with different number of teeth and chains.
Theoretical considerations

- One animal need 0.5 m. of total feedlots length and the amount 8 to 8.5 kg of mixed feed / each meal, with density of 0.4 g/cm$^3$ as recommended by Pond and Church (1995). Then, dimensional theoretical calculations as shown in figure (4).

Actual volume ($V$ = cm$^3$) of mixing auger step (one revolution of auger) =

$$V = \tau \times Gs \times \left[ \left( \frac{D_1}{2} \right)^2 - \left( \frac{D_2}{2} \right)^2 \right]$$
Where:
\[ \tau = 3.14 \]
\[ Gs = \text{length of auger step cm.} \]
\[ D1 = \text{outside auger diameter cm.} \]
\[ D2 = \text{inside auger diameter cm.} \]
\[ V = 3.14 \times 30 \times \left[ \left( \frac{25}{2} \right)^2 - \left( \frac{5}{2} \right)^2 \right] = 14130 \text{cm}^3 \]

The amount \((M = \text{kg})\) of animal feed addition by one revolution of auger =
\[ M = \rho \times V \]

Where:
\[ \rho = \text{Density of mixed animal feed material} \frac{\text{g}}{\text{cm}^3} \]
\[ M = 0.4 \frac{\text{g}}{\text{cm}^3} \times 14130 \text{cm}^3 = 5652 \text{g} = 5.6 \text{kg} \]

Ground wheel perimeter \((Wp = \text{cm.})\)
\[ Wp = \pi \times D \]

Where:
\[ \pi = 3.14 \]
\[ D = \text{Ground wheel outside diameter cm.} \]
\[ Wp = 3.14 \times 32 = 100.45 \text{ cm.} \approx 1 \text{m}(\text{longitudinal distance}) \]

Mixing auger revolution: ground wheel revolution = 3:1
The amount of animal feed addition by one revolution of ground wheel =
\[ 3 \times 5.65 = 16.8 \frac{\text{kg}}{\text{m}} \approx 16 \frac{\text{kg}}{\text{m}} \] ( Accord to ground wheel slippage)

**The studied factors as follows:**
1) Different four forward speeds \((F_{s1} = 1.2) \& (F_{s2} = 2.2) \& (F_{s3} = 3.1) \& (F_{s4} = 4.2) \text{ km/h.} \)
2) Four opening gate ratios (roughage material gate: concentrated material gate) \((G_1 = 1:1) \& (G_2 = 1:2) \& (G_3 = 1:3) \& (G_4 = 1:4) \)
3) Three Revolution ratios (Auger revolution: stirring shaft revolution) \((R_1 = 1:1) \& (R_2 = 1:2) \& (R_3 = 1:3) \)

**Experimental measurements:**
1) **Animal feed adding rate kg/m**, to estimate the feed amount for meter of feedlot longitudinal distance, the plastic bags were used to collect
feed samples from machine hose at different treatments under study according to number of machine ground wheel revelations and its external perimeter. The obtained results compared with experimental results to judge the actual performance of the machine.

2) **Mixing Quality**, before mixing of tested animal feed, take small sample from each type of animal feed materials (0.5 kg each) will mixed manually at the same experimental mixing ratios (opening gates ratios G) then estimating its volume and density (bulk density). Take experimental samples after prototype mixing process and calculated the density of each sample at different studied factors, by comparing the obtained data enable us to limit the optimum density as index to the mixing efficiency.

**RESULTS AND DISCUSSION**

1) **Animal feed adding rate kg/m**

It can be seen from figures (5A to 5C) that the forward speed had an effect on the amount of animal feed provided to feedlots. Increased in forward speed from 1.2 to 2.2 km/h increased this amount due to increased in the vibration of the machine parts during the movement which increase the descent of animal feed quantity. By increased the forward speed from 2.2 to 4.2 km/h we notes that decrease occurred the amount of animal feed provided by machine due to slippage occurred to machine ground wheel.

![Animal feeding rate Kg/m at different forward speeds (Fs) and opening gate ratios (G) at revolution ratio R1 = (1:1).](image-url)
From the other side increased the value of R (Auger revolution: stirring shaft revolution) leads to increase the amount of animal feed adding rate kg/m, the heist value was 16.9 kg/m occurred with R3 = 1:3. The optimum amount of animal feed provided was 16 kg feed/ 1m of feedlot longitudinal distance obtained at a lower forward speed Fs1 = 1.2 km/h with R3 = 1:3 this result conforming with theoretical consideration.

2) Mixing Quality
Referring to figures (6A to 6C) one can notice that, animal feed mixed material density increased with opened feed gates ratios rate (G) and Auger revolution:stirring shaft revolution ratios (R), this trend with different forward speeds (Fs) treatments under study, this results can be due to increased descent rate of the animal feed material which may lead to compression of feed material particles thereby increased the virtual density.
Fig. (6A): Mixing quality at different gate opening ratios (G) and forward speeds (Fs) with revolution ratio (R2 = 1:1).

Fig. (6B): Mixing quality at different gate opening ratios (G) and forward speeds (Fs) with revolution ratio (R2 = 1:2).

Fig. (6C): Mixing quality at different gate opening ratios (G) and forward speeds (Fs) with revolution ratio (R3 = 1:3).
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الملخص العربي

آلة لخلط وتقديم الأعلاف الحيوانية

د. طارق حسني الشبراوي

تعتبر الأعلاف الحيوانية وطرق خلطها وتقدمها للمواشي من أهم الأمور التي لها تأثير على صحة ونمو وجودة إنتاج المواشي سواء من الحمّ أو اللبن بالإضافة إلى ارتفاع كفاءة شراء العلائق مما يوجب الحرص على عدم إهدار أو تفلي كمية منها أثناءخلطها أو تقديمها للمواشي. في معظم مزارع الإنتاج الحيواني خاصة الصغيرة تتم عملية الأعلاف المحكرة مع المواد المائدة على أرضية المزرعة بيديا وتقدمها عن طريق العامل نفسه مما يربك عليه عدم الجودة في عملية الخلط بالسبب الموسي بوجود مزرع المواد المكونة لمادة العلفة جيدا بالإضافة إلى إهدار كمية من العلائق عبر اختلاف بالروف ومع صعوبة تقدير الكميات المطلوبة من العلائق لعملية التغذية بواسطة العامل البشري، هذا ويلاحظ أن خلط الأعلاف وتركها لفترة أو تخزينها عند الحاجة يترتب عليه بعض التفاعلات البيولوجية والكيميائية التي تؤثر سلبا على التعلم المستضاع للعليقة وفقدانها لكثير من قيمتها الغذائية وتعرضها أحيانا كثيرة للتفت وتكوين العفن في المناطق أو المزارع بالمناطق الرطبة.

قامت هذه الدراسة بغرض تصميم آلة بسيطة من خامات متوفرة لتسهيل اعمال الخلط والتقديم للعائلات الحيوانية (المركز – المائدة) في نفس الوقت ويمكن التحكم في نسبة الخلط وكمية العلائق المقدم للحيوانات ومصمتة الآلة بحيث يمكن دفعها بدون أو شبكها بالجرار في حالة المزارع الكبيرة. وتقييم آداء الآلة تم دراسة عدة متريرات هي سرعة تقدم الآلة (Fs) براعير مستويات (1.2 – 2.1 – 3.1 ك/ساعة)، ونسخة قبلي بوبات العلائس الموجودة بقاع خزان العلائق المركبة. وتتم اختيار أربعة نسب لفتح بوبات خزان مادة العلف المائدة: فتح بوبات خزان مادة العلائق المركزية (G)، وتم اختيار أربعة نسب بين سرعة دوران (R) فتح خزان خزان العلائق: سرعة دوران عمام تقليب مادة العلف داخل خزان الآلة (R) 1 – 2 والتي النتائج teste على نتائج رابعة (2012). وتتم تجربة الآلة بمزجرة محطة بحوث الجمبيزة - محافظة الغربية (صيف عام 2015) وتقدير كمية العلائق المصصة بواسطة الآلة 10 متر طول من مروج تغذية المائدة، بالإضافة إلى كفاءة الآلة في عملية خلط مواد علائق (جودة عملية الخلط)

وأوضح النتائج النتائج على جودة الألية وسهلية استخدامها ودقتها في تقديرها للعليقة بالنسبة للمرجحة، وأوضحت أن النتائج أن استخدام الآلة مع السرعة المنخفضة (Fs = 1.2 ك/ساعة) نسبة فتح بوبات العلائق (G) = 10/10/10، ونسبة سرعة دوران بريق الخلط: سرعة دوران عمام التقليب = 2.1 = أعطت أفضل نتائج كمية العلائق المقدمة كجم/س من طول مروج التغذية 16 كجم/س.

ويصبح بتعزيز استخدام مثل هذه الآلات بالمزارع لتسهيل استخدامها وبسيطة تركيبها ودقة عملها.

* منير بكين رئيس الدراسات الزراعية - كلية الزراعة - جامعة المنصورة.
** وليد أ. بحوث ميدانية للعلائق الحيوانية - قسم بحوث الدراسات الزراعية - جامعة الزراعة
*** إعلامي رئيس قسم بحوث الدراسات الزراعية - كلية الزراعة - جامعة الإسكندرية.

MISR J. Ag. Eng., January 2016 - 12 -