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Effect of Threshing Speeds and Feeding Weights on the Maize Threshing Machine Efficiency

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Abstract. An experiment was conducted to study the effect of threshing speed and feeding weights on the maize threshing machine efficiency, threshing speed of the threshing machine included 270, 470 and 570 rpm, the feeding weights of the threshing included 4, 7 and 10 kg, in the specific productivity, specific energy consumed, threshing efficiency and broken cobs. The results showed that increasing the speed of threshing unit from 270 to 470 then to 670 rpm had a significant effect on specific productivity, specific energy consumed, threshing efficiency and broken cobs. Increasing the threshing feeding weights from 4 to 7 then 10 kg led to increasing the specific productivity along with a decreasing in the specific energy consumed, threshing efficiency and broken cobs .The highest specific productivity was 7.98 kg/kw.h. The least specific energy consumed 0.127 kwh/kg at the threshing speed of 470 rpm and the feeding weights 10 kg. While the threshing efficiency was 100% with broken cobs of 0%, at 470 rpm threshing speed for all of the feeding weights.

Keywords. Feeding weights, Maize, Energy consumed, Machine productivity, Broken cobs.

1. Introduction

Yellow corn (*Zea mays* L.) is one of the strategic crops that have a major role in the supports national Economy, and its contribution to the development of manufacturing industries. As well as, in the aspect of livestock production to provide green and concentrated fodder [1]. As it ranks third after wheat and rice in terms of cultivated area [2]. It is known that maize is one of the most important crops in Iraq and in most regions of the world [3]. This explains its significance in animal feed and human diet in the world [4]. Usage of yellow corn direct in human eating or in industry, and preparing of poultry and animal feed, whether it be dry or soft [5]. In addition to the dependence of many important industries on it as a raw material [6]. In order to sustain high levels of crops and improve its quality and quantity, nowadays needs to reduce energy consumption and minimize grain losses during preprocessing [7]. [8] Indicated to the importance of adjustment of threshing unit and rates of feeding with kernels. [9] Showed that the accurate adjustment for the threshing mechanism of yellow corn (maize) can result in a 100% threshing ratio along with no losses. [10] Indicated that among the most important factors in threshing machine performance are the threshing speed of threshing, grains moisture content and threshing feeding rate with kernels. He also indicated that threshing mechanism

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is considered among the most important part of the threshing that affects energy consumption and threshing productivity. [11] reported that the organizing of machine has an effect on the productivity of the machine, that Threshing productivity is Effected by the threshing speed of the Threshing unit, The better the machine is organized, the higher of productivity and low percentage of break-up and this is led to increased efficiency of work. [12] Mentioned that increasing the feeding rate with kernels into the threshing unit leads to increasing the productivity nevertheless leads to increasing the grains broken ratio along with decreasing threshing efficiency. [8] mentioned that conducting many studies to improve the mobile corn threshing machine performance, thus making it functioned with a bigger better efficiency. [13] Indicated that among the main factors that affect the circumstances of the mechanical threshing of the yellow corn is the rate of feeding with the kernels. Whereby it was adjusted according to the grains state and the threshing specification. While keeping the cob maize's moisture content constant, the feed rate and rotational speed have an impact on the needed specific energy [14]. The research aims to studying the effect of threshing speed and feeding weights on the maize threshing machine efficiency.

2. Materials and Methods

A corn threshing machine was created locally and test was carried out in the mechanical workshop of the department of agricultural machines at the College of Agricultural Engineering Sciences, University of Baghdad. As shown in figure (1). An experiment was conducted to study the performance of the yellow corn threshing that is locally manufactured. Threshing cylinder dimensions was length 100 cm, diameter 46 cm and engine speed 1420 rpm. Threshing mechanism is comprised of 18 chains, distance between a chain and another is 10 cm. the movement is transmitted to the carrying shaft by belts and pulleys. A wired sieve is placed underneath the threshing unit. In order to test the threshing, yellow corn/maize kernels were used that were bought from a grains silo. The moisture content was recorded 6.3% that was measured directly by an electronic device. The threshing speed was measured by an electronic laser device. Three threshing speeds were used 270, 470 and 670 rpm along with three threshing feeding weights 4, 7 and 10 kg according to three replications. The test treatments were organized according to the complete randomized design. The significance of the effects were tested according to (LSD) at the probability of 0.05. The program of SAS [15] was used to analyze statically.

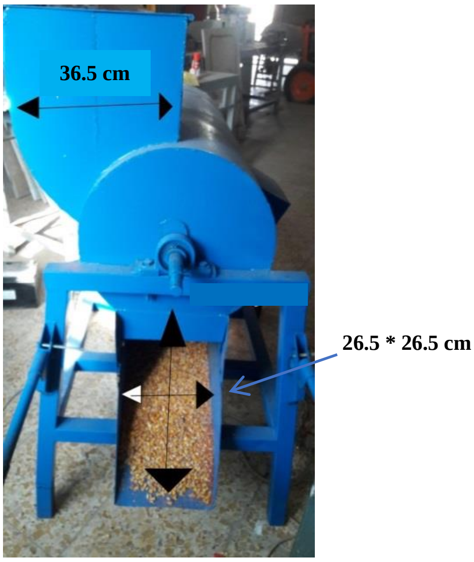

Figure 1. The local threshing used in the experiment.

Where by the following indicators were measured along with its equation:

2.1. Specific Productivity (kg/kwh)

In the first part to measure the results, the threshing productivity was calculated using a digital scale and timing watch. After functioning the threshing according to a given fixed time per experimental unit. Average while the consumed electricity by the grinder engine was measured by using a clamp meter. Thus the specific productivity is calculated according to the following equation that is mentioned by [16]:

$$S.C = C/P \text{ ....kg/kwh}$$

Where:
C: The productivity (kg/h)
P: The consumed power (kw)

2.2. Specific Energy Consumed (kwh/kg)

The specific energy consumed was calculated during threshing operation after determining the threshing productivity and the consumed engine power, thus the specific energy consumed is calculated according to the equation provided by [17]:

$$S.E = P/C \text{................kwh/kg}$$

Where:
P: The consumed power (kw)
C: The productivity (kg)

2.3. Threshing Efficiency (%)

The efficiency of the threshing is measured by the weight of the total unthreshed grains that are being left on the cobs in respect to the total threshed grains / grains, eventually extracted as a percentage ratio, according to [18]:

$$\text{Threshing efficiency} = 100 - (\text{Weight of unthreshed grains} / \text{Totatl weight of threshed grains})$$

2.4. Broken Cobs (%)

The broken yellow corn cobs were calculated after separating the broken cobs per treatment in respect to the total cobs weight, thus calculating it as a percentage ratio according to the equation mentioned by [19] as follows:

$$\text{Broken cobs} = (\text{Weight of the broken cobs} / \text{Primary weight of the broken cobs}) \times 100$$

3. Results and Discussion

3.1. Specific Productivity (kg/kw.h)

Figure 2 shows the effect of threshing speed and feeding weight of threshing machine on the specific productivity, whereby increasing the threshing speed from 270 to 470 then to 670 rpm had a significant effect in specific productivity of 6.68 kg/kw.h, that was recorded the highest with the speed of 470 rpm. That’s due to the reason of decreasing the consumed power along with increasing the threshing productivity because the presenting of an inverse relationship between the decreasing in the consumed power and the specific productivity. That is in coherent with [14,20].

It’s also obvious that increasing the feeding weights rates into the threshing from 4 to 7 then to 10 kg had a significant effect in increasing the specific productivity from 3.93 to 5.57 then to 6.34 kg/kw.h. The reason is due to the increasing of the threshed corn/maize quantity is accompanied with the increasing of the feeding weights [8,10].

Figure 2 shows that the interaction between threshing speed and feeding weights has a significant effect in the specific productivity whereby 7.98 kg/kw.h were the highest that had been recorded with the threshing speed of 470 rpm and feeding weight 10kg. The least specific productivity was 2.23 kg/kw.h had been recorded with the threshing speed of 270 rpm and the weight of 4 kg.

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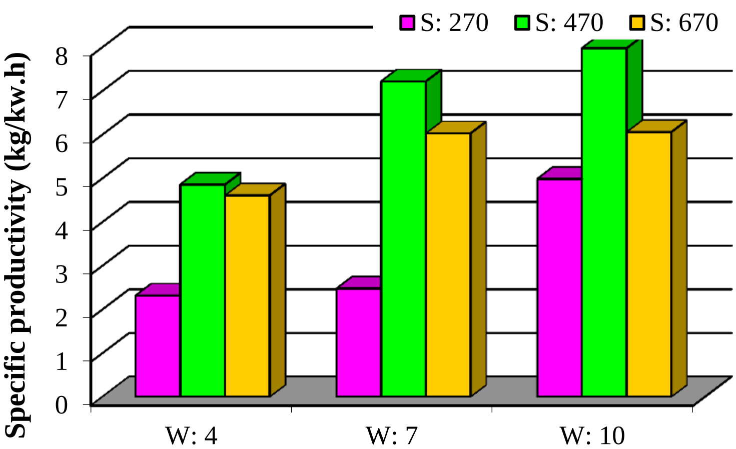


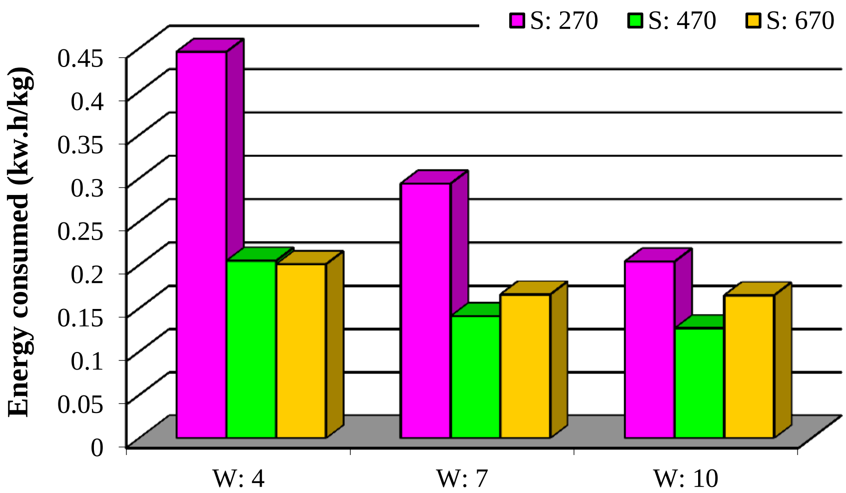
*S: Threshing speed (270, 470, 670 rpm),
W: Feeding weights (4, 7, 10 kg).

Figure 2. Effect of the rotational speed and feeding weight of threshing machine on the specific productivity (kg/kw.h).

3.2. Specific Energy Consumed (kw.h/kg)

Figure 3 shows the effect of threshing speed and feeding weight of threshing machine on the Specific energy consumed. A significant effect was recorded during increasing the threshing speed from 270 to 470 then to 670 rpm, whereby the least recorded specific energy was 0.157 kg.h/kw with the threshing speed of 470 rpm. That's due to the fact of the suitability of this speed with the quantity of the corn/maize kernels feeding weights provided into the threshing [21]; [22] that indicated that the threshing speed of the threshing unit had a significant Effect on the specific energy.

Figure 3 shows that increasing the feeding weights from 4 to 7 then to 10 kg led to specific decreasing the specific energy from 0.284 to 0.200 then to 0.165 kw.h/kg. the reason of that decreasing , is due to the increasing of the Threshing productivity along with the increasing of the feeding weights led to that decreasing in the specific productivity, because the existing of an inverse relationship between the productivity and the specific energy, that is in consistence with [23].



*S: Threshing speed (270, 470, 670 rpm),
W: Feeding weights (4, 7, 10 kg).

Figure 3. Effect of the rotational speed and feeding weights of threshing machine on the specific energy consumed (kw.h/kg).

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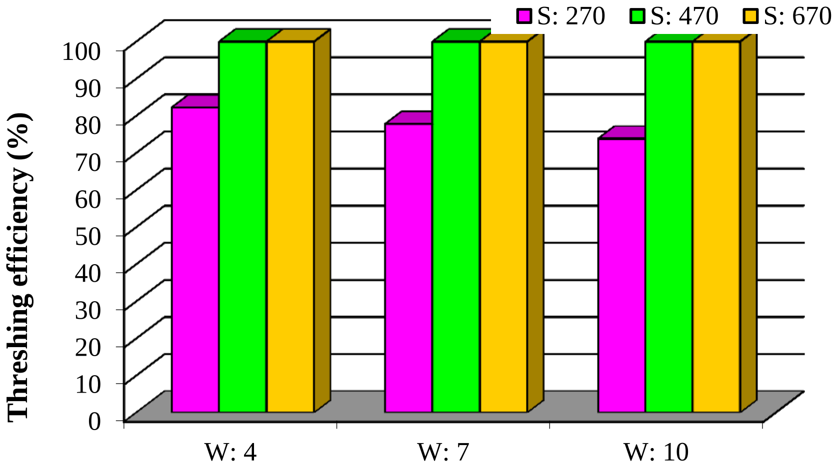
Figure 3 shows a significant effect of an interaction between threshing speed and feeding weights in the specific energy consumed. Whereby the least recorded specific energy was 0.127 kwh/kg with the speed 470 rpm and feeding weights of 10kg, whereas the highest specific energy was 0.446 kwh/kg with the speed 270 rpm and feeding weights 4 kg.

3.3. Threshing Efficiency (%)

Figure 4 shows the effect of threshing speed and feeding weights of threshing machine on the threshing efficiency. accordingly, increasing threshing speed from 270 to 470 then to 670 rpm affected specifically in the threshing efficiency, whereby the speed of 270 rpm recorded threshing efficiency of 100%, that's due to the fact that the speeds of 470 and 670 rpm were accompanied by a complete threshing of grains/grains along with zero attached grains on the out coming cobs [10,24]. Figure 4 indicates that increasing feeding weights from 4 to 7 then to 10 kg led to decreasing threshing efficiency from 4.08 to 2.59 then to 91.28 %. that's due to the increased unthreshed grains were accompanied by the increased feeding weight along with the time constancy allocated for threshing, which led to a threshing decreasing, [8,10].



*S: Threshing speed (270, 470, 670 rpm),
W: Feeding weights (4, 7, 10 kg).

Figure 4. Effect of the rotational speed and feeding weight of threshing machine on the threshing efficiency (%).

The interaction between the threshing speeds and the feeding weights had also indicated to a specific advantage for the speeds of 470 and 670 rpm that were recorded with all of the feeding weights accompanied with a threshing efficiency of a 100%, whereas threshing efficiency at the speed of 270 rpm had decreased specifically and resulted in recording the least threshing efficiency of 73.85% with the feeding weight of 10 kg.

3.4. Broken Cobs (%)

Figure 5 shows the effect of threshing speed and feeding weights of threshing machine on the maize broken cobs during threshing. The speeds of 270 and 470 rpm, haven't recorded any broken cobs, whereas the threshing speed of 670 rpm recorded broken cobs of 45.92%, [25] whom found that an appropriate threshing high speeds lead to increasing the broken ratio of both grains and cobs during Threshing operation. Figure 4 indicates that increasing feeding weights from 4 to 7 then to 10 kg led to a decreasing in broken cobs from 18.27 to 14.47 then to 13.18 %. The reason for this is due to the increase in the number of kernels that are fed to the machine, which leads to a reduction in the chances of collision during threshing, and this has led to a reduction in the percentage of broken cobs and grains, that is in consistence with [23].

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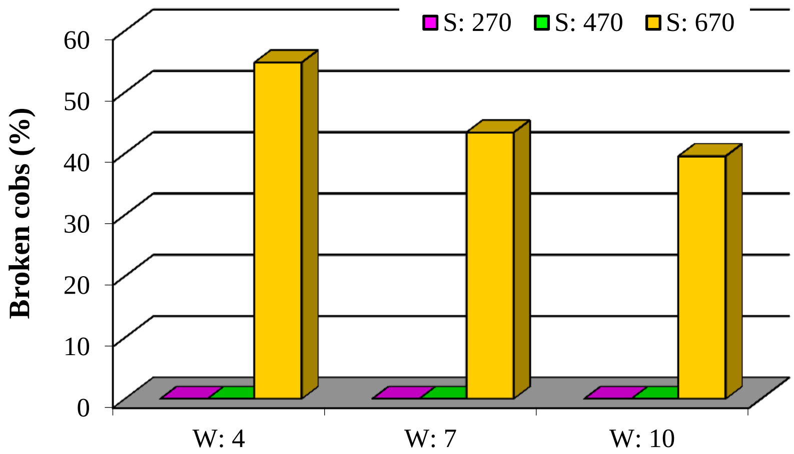

*S: Threshing speed (270, 470, 670 rpm),
W: Feeding weights (4, 7, 10 kg).

Figure 5. Effect of the rotational speed and feeding weight of threshing machine on the broken cobs (%).

Figure 5 shows that there is a significant effect of interaction between the threshing speed of threshing and feeding weights in the broken cobs. whereby no broking was recorded in the cobs, with the speeds of 270 and 470 rpm and in respect to all feeding weights, whereas the broken cobs in respect to all the feeding weights and the threshing speed of 670 rpm was recorded the highest of 54.81 % and weight 4 kg however the least was of 39.55 % with the weight 10 kg.

Conclusions

The study results showed that increasing threshing speed from 270 to 470 and to 670 rpm has a significant effect on threshing machine specific productivity, specific energy consumption, Threshing efficiency and broken cobs. Increasing the feeding weights from 4 to 7 and to 10 kg has a significant effect led to increasing the specific productivity along with a decreasing in the specific energy, threshing efficiency and broken cobs. We recommend using medium speed 470 rpm and medium feed weight 7 kg, and avoid high or slow speed as well as high or low feed weight because it reduces the efficiency of the machine and increases corn breakage or not threshing well.

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