# On Farm Evaluation and Verification of Maize-Sorghum Thresher

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**Abstract**
*Kombolcha modified motorized maize-sorghum thresher was evaluated to verify its technical performance, efficiency and economic feasibility relative to conventional threshing methods and manual maize Sheller under farmers condition. The study revealed that motorized thresher with output capacity of 41qts/hr and 12.5qts/hr of maize and sorghum respectively is economical than conventional threshing methods. Trampling needs much time and animal power and beating by sticks and rubbing hands requiring more force and degrading quality are relatively less advantageous. The cylindrical maize Sheller seems uneconomical compared with motorized thresher, given its cost and service life is significantly important to farmers. Despite of this to enable thresh varying comb sizes of maize modifications should be introduced to fully and widely utilize the technology. It is more preferable in areas that are remote to transport motorized thresher. Generally it is important to demonstrate and motivate farmers union and other capable individuals to invest in motorized thresher and provide service to farmers for maize and sorghum threshing. Besides, it is crucial to popularize manual cylindrical maize Sheller to the smallholder and females in large since in those off-farming seasons farmers and their families are less busy.*

**Key words**: *motorized maize –sorghum thresher, cylindrical maize sheller, threshing capacity, economic feasibility*

## Introduction

It is apparent that the Ethiopian economy is dominated by agriculture. It accounts for over 50 per cent of GDP, 90 per cent of the export earnings, and 88 per cent of the labor force. Food supply to the urban areas and supply of raw materials to the manufacturing sector are all dependent upon agriculture (FAO, 1995**).**

Crop production is the major activity in the overall agricultural sector. However, this sector is enshrined in several problems including the pre-harvest and post-harvest activities. Thou significant efforts are made to improve the pre-harvest activities, the post-harvest part have been given less attention. Post-harvest losses include the rotting of produce and damage &loss during threshing, storage, packaging and transportation.. The average post- harvest losses of food crops such as *Teff, Sorghum*, *Wheat* and *Maize* are 12-9%, 14.8%, 13.6% and 10.9% respectively (Shimelis Admassu). Among these components of post-harvest activities, threshing is one of the major factors that incur huge loss in cereal production. Threshing of crops in Ethiopia is done by time old traditional practices. It is either done manually or by using animals. By animals, a ground is smeared using cow dung or

irrigating it with water and left to dry. Then the crop to be threshed is laid on the smeared ground upon which several animals tread on. This works for maize and sorghum too. But due to the hardness of these crops for threshing, stick biting is usually accompanied. These threshing methods incur significant loss to the productivity. Besides, along with cracking and damaging of kernels, long stay of crops unthreshed due to lack of treading animals' aggravates productivity loss. So introducing better threshing methods that reduce loss to the productivity of the smallholder is paramount importance.

Recognizing these, Kombolcha research center had modified and evaluated Bako developed maize Sheller (Abay, Geta; 1996). This technology was evaluated with farmers its technical performance, efficiency and economic feasibility and identify possible ways of disseminating the technology.

**Material and Methods**

Demonstration sites were purposively selected based on scale of production. Farmers training center was used to demonstrate sorghum threshing. Both conventional Maize shelling systems, manual cylindrical and motorized threshers were displayed in the demonstration. Information's about animal trampling were taken from Farmers, since it was not possible to conduct trampling test. Farmers were participated on the process of threshing and maize shelling. Manual cylindrical Sheller and stone-rubbing were conducted with different sexs.Semi-structured questionnaire was used to collect farmers' opinion during the process. For motorized thresher of maize, grain from grain and comb outlet as well as sieve over flow was measured. Three separate trials were done and 3 samples from each trial were taken in 10 seconds time length. Weight of threshed and unthreshed grain from sieve over flow, comb and grain out-let is measured to estimate threshing efficieny. Grain samples from each maize separate trial were taken and weight of broken grain measured to estimate thresher breakage. Three varieties of sorghum in different moisture levels were used for the evaluation activity. Three samples from each two of the varieties and one sample from the other variety were taken. Due to out put amount the samples were taken in 45 seconds time prolonged than the time length of maize sampling. Grain from grain out-let, chaff outlet and plain sieve were taken and considered accordingly. Total grain output was weighed to estimate sample similarity in both of the demonstrations. Moreover FAO test procedures were done to ensure machine efficiency.

**Result and Discussion**

As local practice maize and sorghum threshing in the small holder is done by animal trampling, beating by stick and stone rub. The capacity and associated efficiency of conventional and motorized thresher is presented as follows.

***Conventional methods***

*Animal trampling*

It is the treading of animals over the crop. It requires on average 15 oxen for 7hrs and 5 people to thresh a size of 20qts of sorghum while a minimum of 5oxenand 11 people for 2hrs are required to thresh a size of 21qts of maize. A total of 5 and 11 persons are required for 9hrs to direct oxen, sort the comb and thresh the unthreshed sorghum and maize respectively. Trampling speeds up threshing operation, but it reduces the quality of seed obtained since it is mixed with soil along with harming the hoof of animals. While sorghum is mainly trampled in the areas covered, maize is threshed in other methods alternatively.

*Beating by stick ("dulla")*

This operation done with apiece of stick and plastic sacks which is available in any area .It requires more labor than others and damages seeds. Using the plastic sack (madaberia) to avoid spread of seeds, a total of 12 persons and five (5) sacks are used to thresh 21qts of maize in 9 hrs time length .The used sacks are out of use after this operation . In this operation males are mostly the actors, as it requires more force. Eventhou it consumes more labor it is faster than others methods except motorized.

*Stone-rub*

The stone can be (any stone) collected from the area given which has groves. It doesn't crush and spread maize seed. More force is required to thresh maize of larger comb size. Stone-rub occasionally rubs the hands of the individuals in the operation. Threshing of 21qts of maize using stone-rub requires 6 persons for 9hrs,with minimum cost, it is preferable than the other traditional methods. During the test the average capacity was 38 kg/hr.

Table1. Data for comparison of cylindrical manual maize Sheller and stone rubbing (each 30 minutes)

| Type of thresher | Crop Variety | Quantity threshed in each sex category (kg) | | | | | | | Average Output Kg/hr |
|---|---|---|---|---|---|---|---|---|---|
| | | F1 | F2 | F3 | M1 | M2 | M3 | M4 | |
| Cylindrical manual | BH660 | 14 | 10 | 17 | 15 | 18 | 16 | 12 | 29.14 |
| | BH540 | - | - | - | - | 16 | 15 | - | 31.00 |
| | Local | - | 13 | - | | 15 | 19 | - | 31.32 |
| Stone-rub | BH660 | 26 | 19 | - | - | 20 | 25 | - | 45.00 |
| | BH540 | 18 | 20 | - | - | 19 | 14 | - | 35.50 |
| | Local | 13 | 21 | - | - | 15 | 19 | - | 34.00 |

*M-male, F-female

*Cylindrical manual maize Sheller*

This thresher was demonstrated as an alternative. A person using manual cylindrical maize Sheller can produce 30.4kg of maize in 1hr.So it requires roughly 69 persons to shell a size of 21qts of maize in 1hrs time length. The thresher has an estimated service life of 5yrs and cost of 12birr. Cylindrical thresher creates work burden on the farmers to select comb of

maize that fits to the size of the technology, as the height of the internal parts doesn't thresh maize of thicker comb. The smoothness of the Sheller body impedes easy maneuverings. It also rubs the hands of persons when using for a longer period; which requires use of additional materials that prevent rubbing. More over it exposes for tiresome to operate for longer period, than traditional methods including stone-rub. This is so because farmers cannot use their full energy in the case of cylindrical one. Despite the cylindrical manual maize Sheller does not crush and spread maize, how ever due to some manufacturing problems and low promotion, it was not accepted by farmers and was lessly used.

Figure1. Cylindrical manual Maize Sheller

Figure2. Motorized maize-sorghum thresher

*Motorized maize-sorghum thresher*

Motorized thresher with 11 persons for shelling maize (2 on the side of grain outlet, 1 on the side of comb outlet and 8 to feed the machine) has an out put capacity of 41qts/hr of maize on average. While the output capacity of the thresher for sorghum is 12.5qts/hr. The threshing efficiency for maize is 98.3% with breakage of 4.99% and excellent cleaning efficiency. For threshing sorghum, it requires 10 persons (i.e. 1 person in the side of grain outlet, 1 on the chaff outlet and 8 persons to feed the machine) on average to thresh

sorghum with threshing and cleaning efficiency of 93.51% and 88.18% and no significant breakage. During operation the machine operator being permanent on both cases, the fuel requirement of the thresher is 3.125lit/hr and 1.473lit/hr for maize and sorghum respectively. The loss in spread that comes from the plain sieve and chaff/comb outlet is not considered as a loss since farmers easily collect it. Besides breakage is not such considered as loss.

Table 2. Data for motorized sorghum thresher (each sample is taken in 45 seconds time)

| Location | Crop | Variety | Trials | Out put(kg) | | | Grain with husk (kg) | Cleaning efficiency % | Capacity Kg/hr |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Grain | Chaff | sieve over flow | | | |
| Jilie-Timuga | Sorghum | Abshir | 1 | 11.6 | 0.5 | 0.5 | 0.8 | 82.76 | 928 |
| | | | 2 | 14.3 | 1.3 | 0.5 | 0.8 | 87.50 | 1144 |
| | | | 3 | 13 | 1.7 | 1 | 0.8 | 87.70 | 1040 |
| | | Serina | 1 | 17 | 1.8 | 0.6 | 1 | 90.59 | 1360 |
| | | | 2 | 21 | 2.2 | 0.6 | 0.8 | 93.33 | 1680 |
| | | | 3 | 18 | 1.6 | 0.3 | 0.8 | 92.31 | 1440 |
| | | Gobye | 1 | 12.8 | 1.6 | 1.2 | 0.6 | 83.05 | 1024 |
| Average value | | | | | | | | 88.17 | 1230 |

Table 3.Data for motorized maize threshing (each trial is taken in 10 seconds time)

| Location | Crop | Variety | Trials | Out put(kg) | | | Wt. of threshed & unthreshed grain from comb outlet (after hand threshing) (kg) |
|---|---|---|---|---|---|---|---|
| | | | | Grain | comb | Sieve Over flow | |
| Bure | Maize | BH660 | 1 | 7 | 0.095 | 0.0297 | 3 |
| | | | 2 | 7.7 | 0.114 | 0.0189 | 3.3 |
| | | | 3 | 11 | 0.091 | - | 4 |
| | | BH540 | 1 | 12.7 | 0.097 | - | 4 |
| | | | 2 | 10 | 0.095 | - | 3.3 |
| | | | 3 | 12 | 0.357 | - | 4 |
| | | Local | 1 | 11 | 0.421 | 0.344 | 5 |
| | | | 2 | 14 | 0.448 | 0.330 | 4 |
| | | | 3 | 13 | 0.219 | 0.306 | 5 |

Motorized thresher, with estimated service life of 10yrs and cost of 50700ETB, is better compared to the traditional methods. Neverthless; it requires more labor for feeding and guard at the inlet (hopper opening) to protect the spread out of crop to the operator. During the test with the farmers they give comment that" the inlet opening better to be circular and the guard should be on this side so that can protects spread of the seed and blow on the feeders". The open space along the horizontal of the inlet opening the threshed & un threshed crops in addition the dust like material and creates serious problem on the threshing operation. In order to utilize with full capacity of the machine, it requires more

feeding and decrease the spreading out of the seeds at the inlet opening, otherwise it consumes similar amount of fuel with less threshing output(capacity).

Table 4.Data of samples in maize breakage for motorized thresher

| Variety | Sample | Wt. of total sample in kg | Wt. of broken grain in kg | Wt. of clean grain in kg | Average wt. of sample in kg | Average wt. of broken in kg | Average wt. of clean grain in kg | Breakage in % |
|---|---|---|---|---|---|---|---|---|
| BH660 | 1 | 0.190 | 0.015 | 0.155 | 0.184 | 0.013 | 0.162 | 3.76 |
| | 2 | 0.200 | 0.011 | 0.183 | | | | |
| | 3 | 0.161 | 0.013 | 0.148 | | | | |
| BH540 | 1 | 0.250 | 0.016 | 0.235 | 0.260 | 0.0170 | 0.230 | 3.47 |
| | 2 | 0.280 | 0.0191 | 0.246 | | | | |
| | 3 | 0.250 | 0.0164 | 0.209 | | | | |
| Local | 1 | 0.200 | 0.0281 | 0.146 | 0.197 | 0.0243 | 0.143 | 7.74% |
| | 2 | 0.190 | 0.0231 | 0.131 | | | | |
| | 3 | 0.200 | 0.0217 | 0.153 | | | | |
| Average maize breakage | | | | | | | | 4.99% |

Table 5.Test result of the maize sorghum thresher (FAO test procedure)

| Parameters | Value in each sample | | | |
|---|---|---|---|---|
| Sample measurements | Sample-1 | Sample-2 | Sample-3 | Average |
| Crop/Varity | Maize | | | |
| a. Time of sampling run (sec) | 10 | 10 | 10 | 10 |
| b. Weight of threshed grain at main grain out let per unit time (kg) | 8.60 | 11.6 | 12.7 | 10.96 |
| c. Weight of threshed grain at all others grain out let per unit time (kg) | 0.32 | 0.28 | 0.69 | 0.43 |
| j. Weight of un threshed grain at all others out let per unit time (kg) | 0.10 | 0.18 | 0.36 | 0.21 |
| Sample results | | | | |
| 1. Total grain output (A = b + c + d ) (kg) | 9.02 | 12.06 | 13.75 | 11.79 |
| 2. Percentage of un-threshed grain (N = j\A x 100) (%) | 1.1 | 1.5 | 2.6 | 1.73 |
| 3. Threshing efficiency (100 - N) (%) | 98.9 | 98.5 | 97.4 | 98.26 |
| 9. Out put capacity (W = b+c) (kg/hr) | **3211** | **4277** | **4820** | **4102** |

Result Summary of maize

1. Percentage of un-threshed grain = 1.73%
2. Threshing efficiency = 98.30%
3. Out put capacity = 41quintal/hr

**The economic data is summarized as follows**.

***Comparative advantage of motorized thresher over local and manual for maize threshing***
The comparative advantage in terms of partial budget is done for all traditional methods and cylindrical manual thresher in comparison to motorized thresher for threshing a size of 21qts of maize and 20 qts of sorghum; which based at the capacity of trampling. Working days per year for motorized thresher is assumed 90 days per year and 6hrs per day. To analyze the cost advantage of the thresher we used the straight line method for calculating the depreciation cost and cost of the machine per hour.

**Partial budget of motorized maize Sheller over stone-rub for maize**

| **Additional costs** | **Additional benefits** |
|---|---|
| Depreciation = 4.39 ET.Birr | ## |
| Maintenance = 4.39 ET.Birr | (quality degradation) |
| Fuel = 9.78 ET.Birr | |
| Operator = 3.47 ET.Birr | |
| Labor = 8.58 ET.Birr | |
| **Reduced returns** | **Reduced costs** |
| ## (breakage) | **Labor=83.03** ET.Birr |

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(A)Additional costs and reduced returns=38.73ETB

(B) Additional benefits and reduced costs=83.03 ET.Birr

Net benefit=B-A=83.03-38.73=**44.3 ETB**

**Partial budget of motorized over trampling**

| **Additional costs** | **Additional benefits** |
|---|---|
| Dep. = 4.39 ETB | ## |
| Maint. = 4.39 | (quality degradation) |
| Fuel = 9.78 | |
| Motor. = 3.47 | |
| Labor = 8.58 | |
| **Reduced returns** | **Reduced costs** |
| ## (breakage) | oxen rent= 30.00 |
| | Labor = 148.50 |

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(A)Additional costs and reduced returns=38.73ETB

(B) Additional benefits and reduced costs=178.50

Net benefit=B-A=178.50-38.73= **139.77ETB**

**Partial budget of motorized maize Sheller over stick beating**

| **Additional costs** | **Additional benefits** |
|---|---|
| Dep. = 4.39 ETB | ## |

Maint. = 4.39 (quality degradation, breakage)
Fuel = 9.78
Motor. = 3.47
Labor = 8.58

**Reduced returns** **Reduced costs**
## (breakage) Cost= 25
Labor=162

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(A)Additional costs and reduced returns=38.73ETB (B) Additional benefits and reduced costs=187
Net benefit=B-A=187-38.73= **148.27ETB**

**Partial budget of motorized maize Sheller over cylindrical manual Sheller**

**Additional costs** **Additional benefits**
Dep. = 4.39 ETB ##
Maint. = 4.39 (selection of comb size)
Fuel = 9.78
Motor. = 3.47
Labor = 8.58

**Reduced returns** **Reduced costs**
## (breakage) Cost= 2.40
Labor=123

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(A)Additional costs and reduced returns=38.73ETB (B) Additional benefits and reduced costs=125.40
Net benefit=B-A=125.40-38.73= **86.67ETB**

**Partial budget of motorized maize sorghum thresher over trampling for sorghum**

**Additional costs** **Additional benefits**
Dep. = 13.71ETB ##
Maint. = 13.71 (quality degradation)
Fuel = 14.16
Motor. = 3.47
Labor = 24

**Reduced returns** **Reduced costs**
## (breakage, threshing inefficiency) oxen rent=315
Labor = 67.5

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(A)Additional costs and reduced returns= 69.05ETB (B) Additional benefits and reduced costs= 382.5
Net benefit=B-A= 382.5-69.05= **313.45ETB**

*The symbols (##) under the reduced returns and additional benefits shows the presence of items that should be included. While it is possible to estimate breakage loss of the thresher, it is impossible to get loss in quality degradation, breakage and selection of comb size when using traditional methods and manual Sheller. As a result reduced returns of the*

*machine (breakage) & additional benefits of the machine are not considered since, more or less, they are insignificant under small holder conditions and immeasurable respectively.*

For the crop maize the advantage of motorized thresher seems insignificant, in monetary terms, compared to stone-rub. Even then, the hardness of the work with stone-rub, easy tiresome of individuals along with discomfort in rubbing hands makes motorized thresher preferable than stone-rub.Similarly,motorized thresher is preferred than animal trampling due to the economic benefit and shortage of animals ,also damage to kernels and hoof of animals.

Stick beating usually requires more labor to thresh and people get tired easily.Hence, it is not practical to thresh the specified amount of maize within the time limit. Thus with the prevailing economic benefit and reduction of breakage loss, motorized thresher is preferable than stick beating. Manual cylindrical thresher shows economic deficiency relative to motorized thresher. Hence, motorized maize thresher is preferred than manual cylindrical maize Sheller due to the economic gains, time wastage in selection of comb size as well as difficulty of easy maneuverings. For crop sorghum, motorized thresher is more advantages than animal trampling. Generally, with modifications to be introduced, motorized thresher bears crucial for maize and sorghum threshing in the region.

**Conclusion and Recommendation**

Among all threshing systems, Farmers preferred motorized maize-sorghum thresher. The highest cost in terms of maize-sorghum threshing is labor for feeding. Thus it is essential to reduce this cost. Also, the thresher is not available on individual basis under the smallholder and is uneconomical. So it should be given to farmers union or investor like individuals to fetch full advantage of the machine. Moreover means's be searched to enable the manual cylindrical Sheller for different comb sizes and improvements for easiness of maneuvering so that farmers in remote areas could use it. Moreover the following modifications should be implemented

- Better feeding mechanism be searched out for motorized thresher
- Inlet be circular like to enable hold fed crop
- Blowing should be modified in such a way that it avoids spreading and blow of dust on feeders
- Modify manual cylindrical Sheller to enable shell different comb sizes of maize
- Popularization should be done on motorized thresher and manual cylindrical thresher

**REFERENCES**

Abay G. & Geta k. (1996). Test Report on Modification and Evaluation of Bako Model Kombolcha Modified Maize Sheller. Kombolcha, Unpublished.

FAO. (June 1995). Country Information Brief Ethiopia. Rome, Italy

J.H.Herbst & D.E.Erickson. (1996). Farm Management.Principles, Budgets, Plans Stipes Publishing L.L.C.Champaign, Illinois, USA.

Shimelis Admassu. Post- harvest Sector Challenges and Opportunities in Ethiopia. Food Technologist, EARO. Addis Ababa, Ethiopia