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Research Article

Minimization of Postharvest Loss on Cereal Crops Through Capacity Building of Artisans and Youth Groups

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Abstract

The current Ethiopian policy is to strengthen mechanization to improve crop production. The economy depends on agriculture, and the technology imported challenges Ethiopian inducers. The best option is the strength of local manufacturers and artisans. The purpose of this training was to strengthen the artisan and youth groups to improve fabrication quality. The training was conducted on fabrications of maize sheller and metal silo at Melkassa Agricultural Research Centre. The parts of Sheller are: supporter, drum, engine, shaft, chain, and sprocket. The sheller parameters are: speeds, moisture, shelling capacity, efficiency, and grain damage. Metal silo designs parameters: diameter of silo, height, thickness, and density of crop. The material used was galvanized sheet metal (28 gauge), lead, acid, and benzene. The trainers come from Oromia, Amhara, Central Ethiopia, Sidama, and the South Ethiopia region. They equally participated in maize sheller and metal silo fabrication. Oromia and Amhara (28%), Central and South Ethiopia (17%), and Sidama (10%) of the artisans successfully participated. They cover theoretical and practical sessions, and they can fabricate quality sheller and metal silos. After the training, they can develop their business, and it results in the minimizing of crop as it improves the accessibility of the technologies. Ethiopia's policy aims to improve crop production through mechanization, focusing on local manufacturers and artisans. A training program was conducted at the Melkassa Agricultural Research Centre to improve fabrication quality of maize shellers and metal silos. The training involved trainers from various regions, with 28% of participants successfully participating. The training helped artisans improve their skills, leading to business development and reduced crop loss, thereby enhancing technology accessibility.

Keywords

Training, Maize Sheller, Metal Silo, Fabrication

1. Introduction

Management of postharvest loss is the main current status issue for developing countries to ensure a food security system, increasing smallholder farmer income, and improving food availability in local and international markets [1]. the management of harvesting, threshing, shelling, and grain storage is more considerable operation because postharvest losses include not only crop loss but also loss of human effort, farm inputs, livelihoods, investments, scarce resources, and time [2].

In crop production, maize is a major crop used for stable food and high potential yields in Ethiopia. shelling of maize is one of the most significant stages of post-harvest loss [3]. Shelling operation, expensive, high drudgery, and non-time effective. According to [4] suggestion: making the technolo-

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gies more accessible and strengthening the local manufacturers with facilitating the working conditions will make the availability of agricultural machinery for Ethiopia Farmers and inducers supported by demonstration and evaluation of these technologies can improve level mechanization. The results indicated that scaling out and up these technologies through supply and demand-driven mechanisms is essential to realize the benefits of using them [5]. Postharvest losses during agricultural operation starts from harvesting, shelling, and transporting and during stored system, handling are common problems. Poor storage systems expose grains to insects and rodents, pest attacks, resulting in significant losses [6]. The appropriate and affordable technology for farmers as well as service providers perform their business by Sheller, thresher and metal silo storage Ethiopian current farming practices. Appropriate technology results in a business model that allows local smallholder farmers access to different maize shelling technologies [7].

According to Tadesse (2020b) understanding the postharvest losses in both quality and quantity is critical point because, they are related to lost income. Postharvest quantity and quality loss of cereal grains in developing countries appears to begin mostly at the farm level, so potential solutions to the problem are required at the same level [8]. According to the literature, it is difficult to obtain precise data on post-harvest losses of food grains in Ethiopia, but the commonly used figure ranges between 20 and 30% and as suggestion many researcher reducing post-harvest loss equals increasing crop productivity [9]. The utilization of small-scale maize Shellers and metal silo storage units are designed for small-scale farmers who require hermetic/airtight storage during dry periods. In Ethiopia, the majority of farmlands are small-scale, changing the mechanization level [10]. Maize germinates primarily in lowland areas. However, the lowlands lack accessible roads for technology use. Sometimes chemicals are used to prevent loss. That chemical will cause human health, but it will not prevent rodents and rats.

To increase the level of mechanization, we introduce and disseminate the technology for fabrication. Training of metal silo and small-scale maize sheller technologies for artisans and youth groups. The purpose of this training was to provide intensive skill-building manufacturing capacity for artisans and young groups on small-scale maize Sheller technology and metal silo grain storage to increase the technology's accessibility. Training of local artisans on small-scale maize sheller and metal silo fabrication can anticipate the farmer's access to the technologies and also minimize postharvest losses. Besides, the promotion of the technologies was to create business opportunities for trained artisans, as they were expected to make and sell sheller and metal silo for small-scale farmers and urban inducers. Such system marking technologies, accessing, and disseminating metal silo is established and operational.

2. Material and Methods

A. Location of the Training Conducted

The training was conducted at the Melkassa Agricultural Research Centre (MARC) department of Agricultural Engineering Research. It was selected for training due to accessibility of the workshop machines, human skill, and secured areas.

B. Methods

The artisan/ youth group was selected by bureau of woredas agriculture. During the selection of artisan and youth groups, the quota sampling methods were used to determine the amount of trainees to balance with our resource. They come from: Oromia, Amhara, Sidama, and South Central Ethiopia: Based on their maize production potential, we selected the artisans from the Oromia region: Adami Tulu, Hararge Fedis, and Illu Abbabor woredas. From the Sidama region, Loke abbay woredas, and from the south-central Ethiopian region, Dereshe, Gorddula. Soro woredas are selected. From the Amhara region, Debra Achafer, Debra Eliyas, Tekusa, and Dera are selected. In each woreda, we randomly selected the artisan groups based on woredas focal group discussion for understanding their skills.

C. Materials

For fabrication of maize Sheller: angle iron 30 x 30x 2 mm, sheet meat 500 x 600 x 2 mm, RHS 40 x 40 x 1mm, round ϕ14mm and ϕ30mm, nuts, flywheel ϕ350mm, pulley aluminum ϕ350mm, chain and sprocket, ϕ30mm were used. For metal silo: galvanized sheet metal 26 gauge, acid to weld, and benzenes' used. For the workshop, machine drilling, lathe machines, arc welding, cutting, and bending machines are used. At the end, the best evaluation result was testing and quality control.

3. Result and Discussions

During this training, there are two parts covered for trainers. These are theoretical parts and practical parts. For both maize Sheller and metal silo, the theoretical parts are given for trainers.

A. Maize Sheller and Metal Silo Theoretical Parts Training Covered

The manufacturing process of a pedal-driven maize sheller was begun by collecting raw materials such as metal sheets, rods, and bicycle parts. Finally, the component parts of maize sheller are assembled. The main component parts of a pedal-driven maize sheller typically include the frame, the parts of the structural framework that hold all the components together. Working principle of small scale maize sheller.

Figure 1. *Picture taken during theoretical session on maize Sheller.*

B. Theoretical Parts Metal Silo

Trainers dealt with theoretical concepts on metal silos for manufacturing concept design parts. Size and geometry are two important design parameters to consider. the radius or diameters and height of the silo wall are determined by the volume or amount of grain stored, as well as the vertical and horizontal pressures, as shown in the equation below, and it is the same as the trends of [11].

$$\text{Volume of silo (V)} = \pi r^2 \text{ h} \tag{1}$$

$$\text{Capacity in Circular silo (m)} = \rho \times V \tag{2}$$

Where: M represents the mass of the crops in (kg), V: represents volume of the silos (m^3), h; the silo wall's height (m), then the silo's radius, denoted by r, (m) and ρ represents the density of the stored material. (Kg/m^3). The silo's pressures during charging, discharging, and resting conditions were calculated based on the formulas.

According to Janssen's Theory, the material's friction with the vertical wall bears the majority of the weight in the bin. The weight delivered to the hopper bottom is extremely light and according to theory Rankine's nor Coulomb's the lateral pressure and The vertical wall of the silos calculated [12].

$$P_h = \frac{WxR}{\mu} \, x \left(1 - e^{\frac{-z}{zo}}\right) \tag{3}$$

$$Z_o = \frac{R}{\lambda\mu} \tag{4}$$

Where: Z_0 represents the mean height silo (m) and z represents the height of corn stored (m).

$$Relative\text{ mean radius (Rm)} = \frac{\text{Area}}{\text{parameter(U)}} \tag{5}$$

Ph: represents the horizontal pressure (N/m^2), Pv; represents the vertical force (N/m^2), W represents the mass of crops and area of silos where known (m^2), Φ is the angle of internal frictions for crop stored while μ, is the coefficient of friction of grain. (μ = tan ϕ).

$$\text{Pressure ratios } (P_R) = \frac{Ph}{P_v} \tag{6}$$

$$\text{Hoop tension on the wall (HT)} = Ph_{max} \text{ x } 0.5D \tag{7}$$

D, is the represents the diameter of the silo (m) and HT, is represent the tensions ($N.m^{-1}$) and to calculate thickness of silos using equation bellow:

$$\text{Stress}_{\text{ max}} = \frac{H_T}{t} = \frac{vertical\ load\ (mm)}{t} \tag{8}$$

$$\text{Check on wall pressure } (\delta_h) = \frac{P_{h\,x\,D}}{2t}$$

$$\delta 1 = \frac{P_{v\,x\,D}}{4xt} \tag{9}$$

σl, denotes the longitudinals stress (MPa), σh represents the hoops stress (MPa) and t is the thickness of the wall (mm).

C. Procedure of metal silo and maize Sheller fabrication

The fabricate parts and assemble based on drawing dimensions. For metal silo fabrication, the material used was galvanized sheet metal 28 gauge. Knowing the dimensions, thickness, and size required, they can fabricate the sheller and metal silos. In this training session, participants were shown the basics of how to make sketches, patterns, and minor geometrical terms using hard papers, scribers, and rulers. The drawing document was prepared based on the 3D for maize Sheller, and metal silo prepared highlights for trainees.

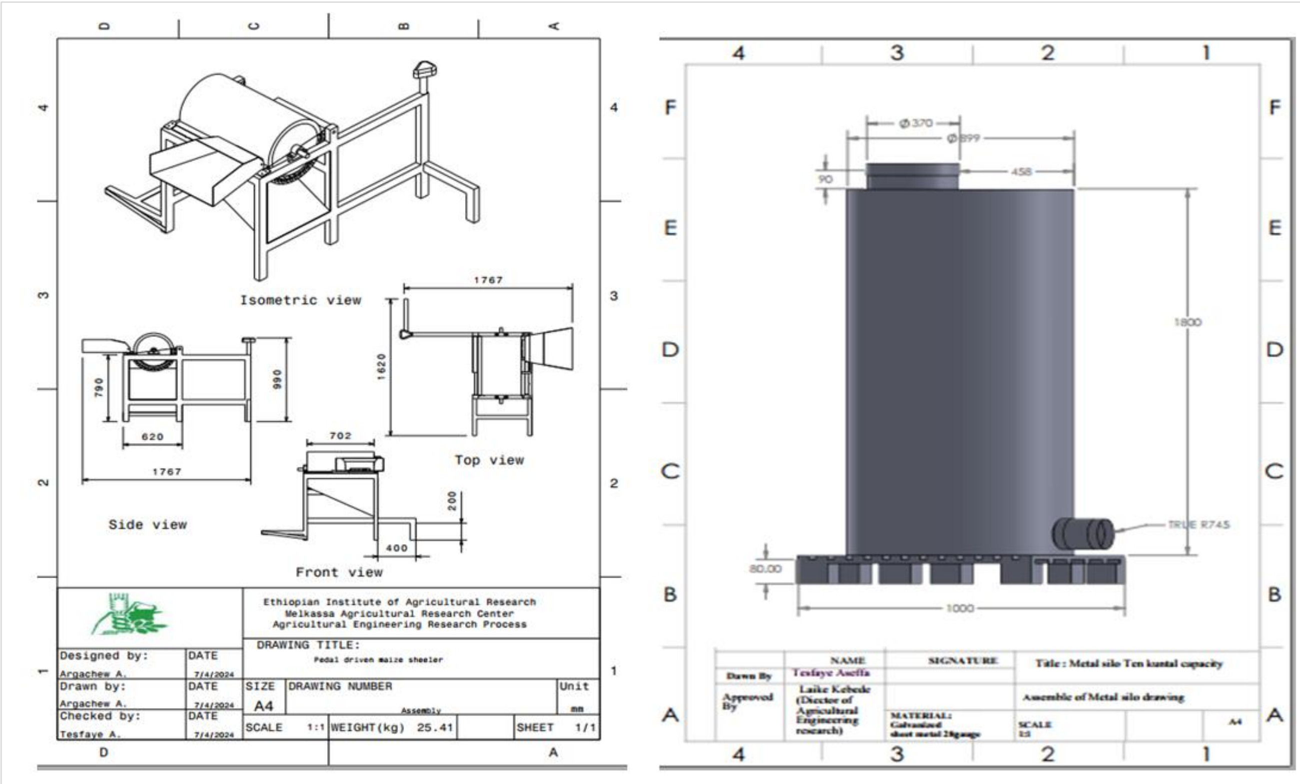

Figure 2. 3D drawing of Sheller and three, six, and ten quintal metal silos.

D. Practical session of small-scale maize sheller and metal silo fabrication with artisans

During these sessions, the trainee learns how to manufacture the maize sheller. First they are understanding drawing with dimensional, and then according to dimension they are started for manufacturing.

Figure 3. Picture taken during visualization of maize sheller parts.

During this session, the artisans get the knowledge of how to read 3D drawings, parts of Sheller, and steps to follow. Then according to dimension, they select material as well as start fabrications.

Figure 4*. Picture taken during the maize shellers started for fabrication.*

During the practical session, the artisan was cutting metal as the dimension given from the drawing. They can confidently fabricate maize sheller without any problem. Final finished works, as assembled, the smoothing strength welding points were performed. Then evaluation of manufacture quality was performed by long-term skilled technicians.

Figure 5*. Final prototype of maize sheller Fabricated by artisans.*

Figure 6*. Artisan/ enterprise trainer taken on maize sheller from different Ethiopian region.*

Figure 6 Represent the number of artisan groups that took trainers on maize shellers that come from different Ethiopian regions. These trainings filled the gaps of local manufacturers and strengthened the manufacturing quality. The gap of artisans in maize sheller manufacturing. After this training, the artisan can fabricate the maize sheller, which will increase the level of mechanization and reduce post-harvest loss through maize sheller usage.

E. Procedure of Metal Silo Fabrication Process During Artisan Straining

During metal silo fabrication, the dimension was prepared as the dimension in the drawing based on their capacity. They also understand the material used for metal silo, which is galvanized steel sheet of 26 gauge.

Figure 7. *Picture taken during metal silo practical session.*

They were started for metal silo fabrication. The tool was prepared for trainees. According to material and tool, they fabricated the silos. Some of the pictures taken during metal silo fabrication are shown below:

Figure 8. *Picture taken during metal silo testing fabricated metal silo.*

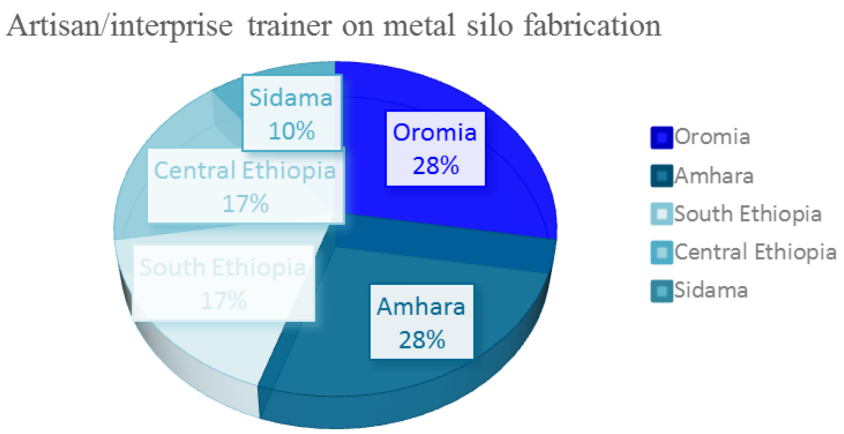

Figure 9. *Artisan/ enterprise trainer taken on metal silo from different Ethiopian region.*

Figure 9. Represent the number of artisan groups that took trainers on metal silo fabrication from different regions. These trainings were successfully conducted in theoretical and practical ways that strengthened the manufacturing quality. After this training, the artisan can fabricate quality metal silos.

Figure 10. *Picture taken during metal silo and maize Sheller certification ceremony.*

Currently the level of mechanization increased due to local manufacturers [13]. Recognizing the benefits of agricultural mechanization was focused on the affordability of the technology, which has been directed toward promoting the accessibility and adoption of pre- and post-harvest mechanization technology [14].

Table 1. *Location metal silo fabricated by artisan.*

No.	Region	Woreas	Metal silo Manufactured in 2023/2024	Capacity of storage in (kg)	Cost of selling In (ETB) per unit
1	Oromia	Adami Tulu	42	600	13500.00
2	Oromia	Diremu	138	69 was 300 69 was 600	7500.00 12500.00
3	Oromia	Fedis book	261	600	13500.00
4	Oromia	Asasa	65	600	1300.00
4	Sidama	LakeAbbay	25	600	13000.00
5	Central Ethiopia	Dereshe	265	14 was 300 251 was 600	7500.00 12500.00
6	Central Ethiopia	Gordula	50	50 was 600	12500.00
7	Amhara	Debra Eliyas	120	600	12800.00

From the above Table 1, in different regions, metal fabrication fabricated by local manufacturers. Also the market demand was created and the inducers well as access to bought metal silos as they need capacity. At the final level, the availability, accessibility, and strength of local manufacturers increase the level of mechanization.

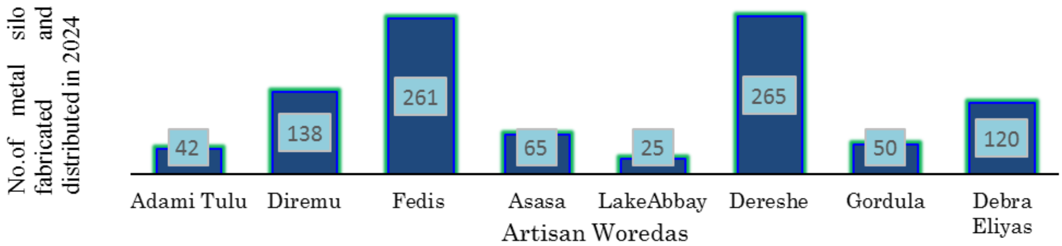

Figure 11. *Figure metal silo fabricated at woreda level.*

In the case of local manufacturers, material cost, labor cost, machine cost, and transport cost are the main parameters. The amount of metal silo fabricated at regional level by artisan also shown below.

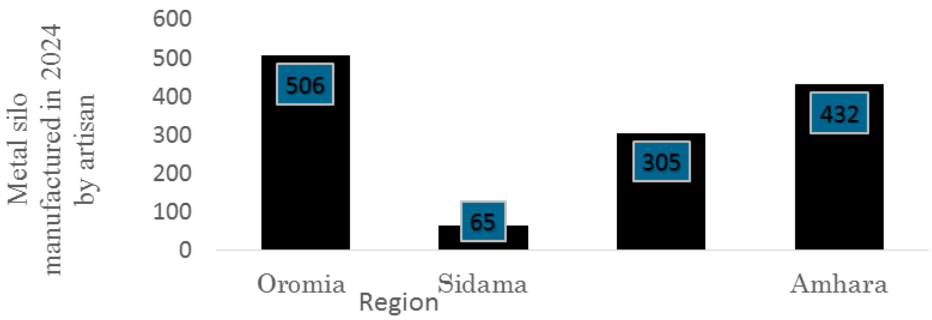

Figure 12. *Metal silo fabricated at Regional level.*

The capacity of local manufacturers, access to and market-oriented technologies, and local manufacturing practices in terms of the quality and quantity of jobs performed, time consumed, labor saved, power consumed, and reduction in drudgery. The metal silos are well promotion and demonstration was conducted. However, linkage with local manufacturers and farmers is not done well. As local manufacturers suggest, working on agricultural machinery will improve the productivity of the country. Hence, the of technologies solely relied on estimations through farmer's recall; hence, quantification of the benefits and comparative advantages of the technologies over traditional practices is approximate.

4. Conclusion and Recommendation

Conclusion

The past 30 artisan that comes from different groups taking training for ten consecutive days in three rounds successfully complied. All the training materials were delivered with the support of the Melkassa Agricultural Research Centre and FAO supports. The training was covers metal silo and maize sheller: design, fabrication, handling, and business development during three successive training sessions. Therefore, all targeted trainees were equipped with equipment for maize sheller and metal silo fabrication, handling, and business development. During these training the trainers captured the technical skills that make easy manufacturing of the technologies. The materials used for training were: sheet metal, galvanized sheet metal, 28-gauge angle iron, RHS, bearings, chains, led, acid, and benzene, etc. material selection consider the durable and resistant to wear and tear. Design the maize sheller depends on: shelling capacity, power consumption, and ease of operation. The goal training was to increase mechanization accessibility in Ethiopia by giving training for young and artisan groups for better sustainable development through the use of technologies, establish a business model for reduction of Ethiopian poverty, and take high credit for gross domestic product [15]. Therefore, further works the strength the artisans on maize sheller and metal silo construction for the selected regions of Ethiopia to change and improve their skill and establishment businesses mode that is changes the economic value and entrepreneurship income for the artisans.

Recommendation

As a recommendation during this training, the artisan and youth groups develop their knowledge on how to quality manufacture maize sheller and metal silos. The gap of the artisan was covered during these trainings. After this training, the artisan should strengthen the entrepreneurship in terms of enterprise. The government institution also supports those artisans by facilitating and giving opportunities for fabrication of maize sheller and metal silo. They have concerted their skills into practical, which increased their experience and developed their groups in practical and economical. The trainees are gaining their skill, especially in practical, and they should strengthen linkages with organizers and nongovernment organizations to demonstrate their quality fabrication. That will create awareness of the maize sheller and metal silos for rural farmers to create a demand. Training for local artisans will increase the mechanization level and also the accessibility of the technologies. Such god things are installed and supported by research organizations and FAO. For the future, the government will also train artisan and youth groups to increase and adopt technologies, resulting in easy increases in the accessibility of the technologies.

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Abbreviations

EIAR	Ethiopian Institution of Agricultural Research
FAO	Food and Agriculture Organization
MARC	Melkassa Agricultural Research Center
RHS	Rectangular Hollow Sections

Author Contributions

Tasfaye Aseffa: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft.

Laike Kebede: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft.

Conflicts of Interest

The authors declare no conflicts of interest.

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