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Pre-Scaling up of Animal Feed Chopper in Selected Districts of West Arsi and East Shoa Zones

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ABSTRACT

This activity was conducted at Adami Tulu Jedo Kombolcha and Negele Arsi districts of West Arsi and East Shoa zones with the objective of creating wider demand for animal feed chopper technology, strengthening stakeholder's linkage for the future scaling up of the technology. With these objectives, the comparison of the technology was done with the traditional way of chopping animal feed chopping practice. It also replicated over four research sites. The result from the finding indicated that animal feed chopper technology had a chopping capacity of 464kg/hr on average with one operator. Whereas traditional animal feed chopping practices using locally available material took 58kg/hr on average with one operator. This finding indicated us animal feed chopper technology had a huge advantage in terms of time minimizing and quality of animal feed being chopped. Data was collected from farmers, DAs, and woreda expertise. Data collected from different stakeholders and data collected during the accomplishment of the research revealed that; the technology had a chopping capacity of about 800%. In addition to this, the technology has many advantages over traditional practice in terms of labor-saving, time-saving, and cost minimization. Two micro interposes were selected from two woredas and practical and theoretical training was given to them. Finally, the linkage between different stakeholders was made for further scaling up of the technology.

Keywords: Scaling up; Chopping; Maize; Sorghum; Stock; Labor.

1. Introduction

Africa's greatest population of cattle is found in Ethiopia (Hussen et al., 2008; Solomon et al., 2003). Livestock is an essential component of agriculture, providing live animals and their products. Ethiopia has diverse agroecologies that are suitable for various types of livestock production; it has the largest livestock population in Africa, with an estimated 65.00 million cattle, 40.00 million sheep, 51.00 million goats, 8.00 million camels, and 49.00 million chickens (CSA, 2020). Livestock contributes significantly to food and nutritional security, as well as providing a source of income for approximately one billion poor people in developing nations (Steinfeld et al., 2006).

More than 85% of Ethiopians live in rural areas, and their economy is based on crop-livestock production and the use of animal power in agriculture (Shapiro et al., 2017). System cattle, particularly in mixed crop-livestock agriculture, play an important role in soil fertility maintenance, and their waste, such as dung, is utilized as fuel and construction materials (Gedefaw, 2015).

The livestock revolution has the potential to be a significant source of revenue for Ethiopian livestock farmers; yet, the lack of access to high-quality feed hinders their capacity to capitalize. Limited access to high-quality feed is a key concern in all Ethiopian production systems (Geleti et al., 2014). Crop residue is now the primary feed resource for cattle in traditional production systems, despite its low quality, high fiber content, and poor digestion of roughages. Coarse feeds are bulky and fibrous, resulting in inadequate nutritional delivery and consumption. Such feeds must remain in the rumen/stomach for lengthy periods of time before being adequately digested to allow for additional feed ingestion. When animals are given low-quality roughages, they often lose weight and condition, produce less, and have trouble reproducing (Feyissa et al., 2014).

Preparing livestock feed is a major issue these days. There was a grazing pasture there formerly. However, the current push to boost agricultural output in every way has increased crop production through the reduction of grazing lands through the expansion of cultivated areas. Farmers that raise livestock, particularly those that raise goats, sheep, and cattle, are frequently confronted with the issue of scarcity during the dry season. Crop residue is the herd's steady source of nutrition, although it generally runs out quickly. One of the main issues with livestock production in Ethiopia is the lack of enough feed during the dry season. Livestock that is grazing has weight loss at this time, and in severe circumstances, some do pass away.

Innovations in science and technology that improve the production, processing, handling, and sorting of animal feed are essential to the productivity, longevity, and output of livestock. To this end, determined attempts are being made to update the livestock feeding chopper.

To solve these problems Asella Agricultural Engineering Research Center adapted an animal feed chopper machine that has a chopping capacity of 4.5 quintal/hr and 5.14 quintal/hr of maize stalk and sorghum stalk respectively. Demonstration of this technology reveals that the chopping of maize stalk was 435 kg/hr and 500 kg/hr for sorghum. Whereas to chop the same amount were fifteen persons for maize stalk and seventeen persons for sorghum stalk. Therefore, the purpose of this study is to popularize the technology of animal feed chopper in selected woredas of the East Shoa and West Arsi zones.

1.1. Study Objectives

(i) To create a wider demand for animal feed chopper technology.

(ii) To improve relationships amongst stakeholders to scale up the technology in the future.

2. Literature Review

2.1. Livestock Feed Preservation Methods

According to Srivastava et al. (2006), the two most frequent ways to preserve animal feeds were silage and hay production. To obtain the nutritional potential of feed, grass or residues must be preserved at the appropriate maturity level. The term "silage" refers to animal feed generated by controlled fermentation of high-moisture herbage. Silage may be generated from both forage and grain crops. It is a way of preserving green fodder crops and storing them for later use. Ensilage is the practice of preserving crops at lactic acidic conditions in airtight containers (silo), ensuring that silage remains succulent and appetizing to animals (Culpin, 1981).

After 21 days after packing, silage can be used at any time; however, silage must be kept anaerobic and not exposed to air. Once unsealed, a container may only store items for 20 to 30 days. Silage production offers several advantages, including a simple method, lower production costs, easier storage and transportation, the preservation of 80 to 85% of the nutritious value of grass or fodder, and the reduction of feed waste due to pests and decomposition (Hou et al., 2017). The first step in making silage is to separate the corn plant from its body and chop it to the desired size. The minced corn is ready for silage. The size and form of the equipment used to chop corn are significant for product quality. The instrument or active element used to cut and chop maize.

According to McEniry et al. (2014), the major elements utilized in silage preparation are grass and green crop leftovers, which are retained; additions are required to increase feed quality and nutrient value. When choosing additions, farmers might use other locally accessible substances, which help to reduce production costs.

There are several methods or procedures used for silage preparation, including inoculant preparation, manual or machine cutting, wilting, chopping, adding additives, packing and sealing silos, storing silos, checking silage quality, and supporting the fermentation process. The equipment needed to prepare silage includes grass harvesters, choppers, and tractors for transportation. The suggested piece size for silage material is 10 to 40 mm for large cow groups and 10 mm for young age groups (Kmickiewicz and Heimlich's, 2015).

2.2. Mechanism of Cutting Plant Materials

Cutting agricultural materials is one of the most common activities, used during harvesting and comminution of plant components. Cutting is the primary step in fodder preparation. Other processing steps also need cutting. Products can be cut separately or in bundles, depending on the material and technical technique (Sitke, 1987).

The cutting plant operates in four ways: slicing with a sharp smooth edge, tearing with a rough serrated edge, high velocities single element impact with a sharp or dull edge, and two-element scissors or shearing type cutting (Chancelleor, 1987).

3. Material and methods

3.1. Materials

Materials used to conduct the pre-scaling up of animal feed chopper technology were a chopper, maize and sorghum stalk, balance, stopwatch, and traditional chopping knife.

3.2. Methods

3.2.1. Site selection

Scaling up of animal feed chopper undertook certain procedures for the selection of kebeles and participant farmers. The first step was to contact of zone’s office of agriculture. Then contact the district’s office of agriculture. Finally, the discussion was held on the objectives of scaling up, the criteria for the selection of the district, and the criteria to select representative kebeles. For the purpose of this study, Adami Tulu Jido Kombolcha and Negele Arsi districts were purposively selected because of their maize and sorghum production potential and accessibility from East Shoa and West Arsi zones respectively.

3.2.2. Kebele selection

Selection of appropriate kebele taking into consideration applicability of technology, accessibility of kebeles to the road for implementation of the activity, scaling up/result diffusion to other non-participant farmers, and representativeness of kebele to other similar kebeles around the selected kebele for further diffusion of the technology through field days. Taking into consideration these criteria four kebeles were selected from two districts where the study was accomplished.

3.2.3. Farmers Selection

Two types of farmers were selected as hosting and participant farmers. Selections of hosting farmers were done with the involvement of all members' farmers, DAs, and representative district experts after a thorough discussion. Selections of demonstration member farmers were done in collaboration with respective Development Agents (DAs). Farmers were chosen based on their desire to engage in all stages of the demonstration, innovativeness of the farmer willingness to allocate resources for the demonstration purposes, willingness to share knowledge and experience among others, and gender balance. For the purpose of this study, four hosts one from each kebele with fourteen members were selected.

3.2.4. Methods and strategies for evaluating and demonstrating technology

The animal feed chopper was scaled up in contrast to the conventional chopping method. The study was done on two treatments which were machine chopping and traditional ways of chopping maize and sorghum stalks. Then the process was replicated on four experimental sites. To facilitate further dissemination of results demonstration method was followed to enable farmers to quickly compare demonstration results with those traditional practices and also method demonstration was used to show farmers step by step how technology works. Field visits/tours and field days were the techniques employed in the scaling-up process to improve farmer-to-farmer learning and information sharing.

3.2.5. Data types and data collecting methods

Both qualitative and quantitative data from original data sources were used in the study. Data collection methods/techniques such as field observation, household/participant interview, and focus group discussion were used to gather primary data, including labor-reduced time, the total number of farmers who attended the training, field visits, and mini-field day by gender, the number of farmers who realized the relative advantage of the technology by gender, the role of farmers and other stakeholders in technology scaling up, and farmers' opinions.

3.2.6. Technique for Analyzing Data

For data analysis, the study used basic statistical analytical methods such as mean values.

3.2.7. Analysis of stakeholders

The research center improved the dissemination of animal feed chopper technology by working closely and consulting often with its relevant stakeholders. To pre-scale actions, several actors need to collaborate. Thus, for institutional arrangements, conducting a stakeholder analysis prior to starting the pre-scaling-up activity was essential. Consequently, stakeholder analysis was done to identify potential stakeholders. The subsequent concerns: Who are the parties involved? To what extent was the project closer to them? What were their roles, duties, and obligations during the course of the activity? Lastly, it was made clear what each actor's responsibilities, duties, and tasks were in executing the action. Four (four) responsible and helpful participating stakeholders/actors were identified in light of this. These consist of the Adami Tulu Jido Kombolcha and Negele Arsi District offices of agriculture, micro-enterprises, the Agricultural Engineering Research Center, and the

offices of agriculture in each zone. A Memorandum of Understanding (MoU) was signed, stakeholder platforms were established at the zone and district levels, and a stakeholder forum was established for a consultation meeting.

3.2.8. Techniques of communication employed

The proper extension approaches and all extension teaching techniques (individual, group, and mass contact methods) were used alone or in combination, depending on the situation, during the pre-scaling-up of the activity.

(i) Dialing a landline or a cell phone.

(ii) Field day workshop (to assess the current situation).

(iii) Study tours or field visits with supervision.

(iv) Technique and result demonstrations.

(v) Group discussions and gatherings.

Table 1. The roles and duties of the stakeholders in carrying out the project

Stakeholders	Roles and responsibilities
Asella Agricultural Engineering Research Center	❖ Facilitation and coordination. ❖ The manufacturing of the technology. ❖ The giving of instruction. ❖ Technological support. ❖ Plan field trips, supervision, and cooperative assessment and monitoring.
Micro-enterprises	❖ Manufacturing of chopper technology for animal feed. ❖ Providing people with technology at a fair price.
District and zone-level Agricultural offices	❖ Assist with location and participant farmer selection. ❖ Follow up on daily activities. ❖ Assist in delivering instruction. ❖ Enable the spread of technology. ❖ Organize and take part in field days together.
Farmers	❖ Provision of materials like crop residues. ❖ Take an active part in the instruction. ❖ Exchange knowledge and expertise with nearby farmers.

4. Results and discussion

4.1. Training

The program was completed successfully by 75 participants, with about 25.3% of them being women and 74.7% being males. The key goals of the program were to promote technology and increase farmer and participant

stakeholder awareness. Following training, stakeholders were made aware of animal feed chopper technology and the next steps for its sustainable use.

Table 2. Training provided to farmers, development agents, and district specialists

Districts	Participants	Male	Female	Total
Adami Tulu Jido Kombolcha	Farmers	22	8	30
	Experts	4	-	4
	DAs	4	-	4
Negele Arsi	Farmers	20	10	30
	Experts	3	-	3
	DAs	3	1	4
Total		56	19	75

4.2. Technology evaluation

The experiment was carried out to estimate the performance of the animal feed chopper machine in comparison with the traditional way of chopping animal feed using locally available materials. The result from the finding indicated that animal feed chopper technology had a chopping capacity of 464 kg/hr on average with one operator. Whereas traditional animal feed chopping practices using locally available material took 58 kg/hr on average with one operator. This finding indicated us animal feed chopper technology had a huge advantage in terms of time minimization and quality of animal feed being chopped.

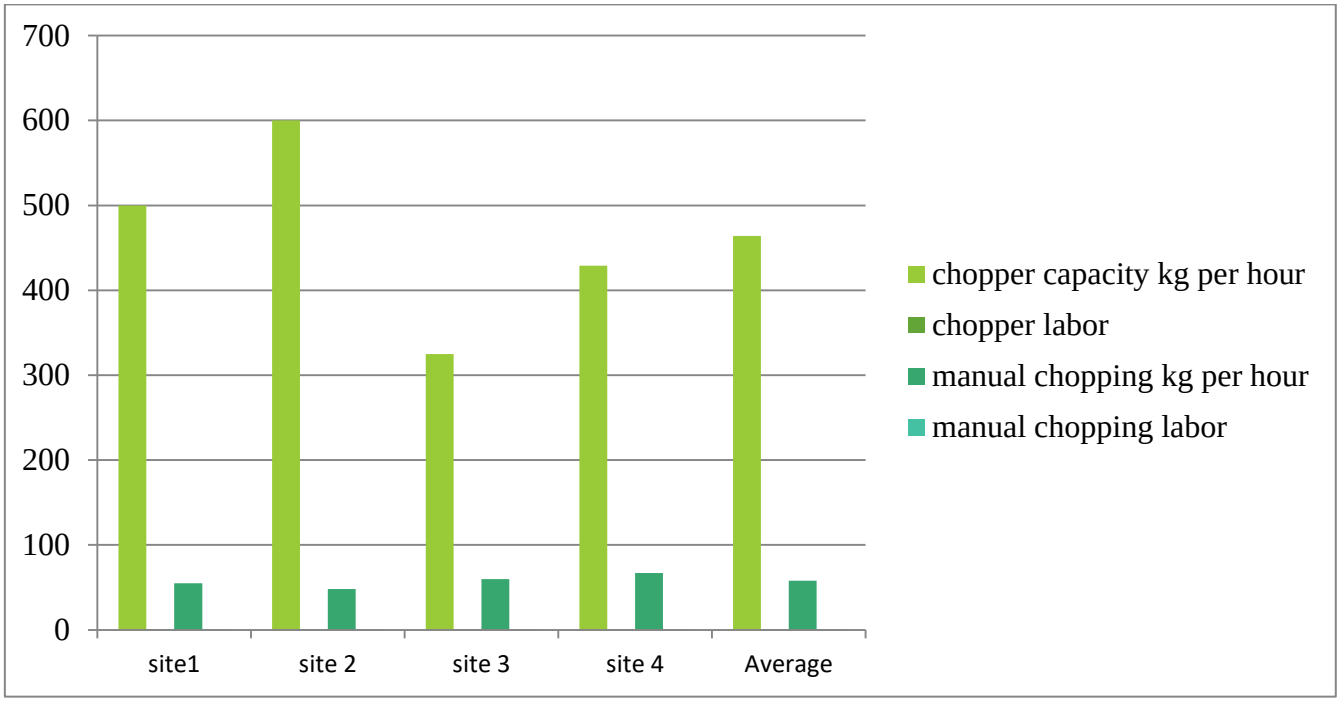

Figure 1. Mean comparison of animal feed chopper and local practice

4.3. Stakeholders` feedback and reaction

A mini-field day was planned as part of the process of popularizing animal feed chopper technology. Various stakeholders, including hosting and non-hosting farmers, development agents, supervisors, experts, and researchers, participated in the field day and offered their reactions to what they saw during the operation of the animal feed chopper technology. They also contrasted it with the conventional method of chopping animal feed. Data like labor and time reduction, chopping capacity, and feedback were collected and analyzed in comparison with local practice. Because of the above-stated quality animal feed chopper technology had a relative advantage over traditional practice. As a result, all participant farmers and stakeholders chose animal feed chopper technology.

4.4. Exit strategy

The mechanism used to transfer technology for wider utilization was; training for capable micro-enterprises that can produce animal feed choppers and avail the technology to nearby farmers at reasonable prices. During the implementation of this research, two micro-enterprises were selected one from each district. Then practical and theoretical training was given to these micro-enterprises. Finally, the linkage was established with the district office of agriculture, research center, and trained micro-enterprises.

5. Conclusions

In the process of popularizing animal feed chopper technology, a mini-field day was organized. Stakeholders participated and reacted to what they observed during the operation of animal feed chopper technology and compared it with the traditional way of animal feed chopping. Data like labor and time reduction, chopping capacity, and feedback were collected and analyzed in comparison with local practice.

Asella Agricultural Engineering Research Center adapted an animal feed chopper machine that has a chopping capacity of 487.8 kg/hr of maize stalk. As well as demonstration result of this technology revealed that chopping capacity of 435 kg/hr. Thus, the result of this finding is nearly the same as that of adaptation and demonstration results. Because of the above-stated capacity of animal feed chopper technology had a relative advantage over traditional practice. As a result, all participant farmers and stakeholders chose animal feed chopper technology. The exit strategy used was training capable micro-enterprises that can produce animal feed choppers and avail the technology to nearby farmers at reasonable prices.

During the implementation of this research, two micro-enterprises were selected one from each district. Then practical and theoretical training was given to these micro-enterprises. Finally, the linkage was established with the district office of agriculture, research center, and trained micro enterprises.

6. Recommendations

Based on these findings the animal feed chopper technology was recommended for further scaling up. Livestock feed is one of the most challenging activities for farmers nowadays. To alleviate this problem concerned stakeholders should focus on mechanization technologies like animal feed chopper.

Declarations

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This study did not receive any grant from funding agencies in the public, commercial, or not–for–profit sectors.

Competing Interests Statement

The authors have not declared any conflict of interest.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

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