International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

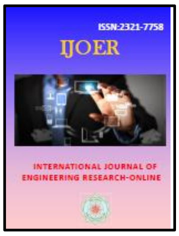
Vol.5., Issue.6, 2017
Nov-Dec

RESEARCH ARTICLE

ISSN: 2321-7758

PERFORMANCE EVALUATION AND VERIFICATION OF WHEAT ROW PLANTER FOR EQUINE ANIMALS, OROMIA, ETHIOPIA

AYALEW BEKELE DEMIE
Oromia Agricultural Research Institute, Asella Agricultural Engineering Research Center, Ethiopia
E-mail: ayalewbekele05@gmail.com



ABSTRACT

In an intensive agriculture increase in crop yield, cropping reliability, cropping frequency and crop returns depend on uniformity and timely establishment of optimum plant populations. Because of tillage repetitions, in Arsi and W/Arsi Zones farmers face draft power shortage during plantation days. To tackle this problem they had practice of using equine animals for this operation by local implements. Thus, this work was focused on adaptation of improved row planter for single animal harnessing system. The technology was redesigned, manufactured and comparatively evaluated with local row planting practice. The evaluation parameters used were labor requirements, time of operation, plant distribution uniformity, seed rate and grain yield. From the results obtained, the improved technology performs well within recommended ranges in distribution uniformity, plant population and improved operation time when compared with local practice. With these merits, the technology had recommended for large scale use in the study area.

Key words: Equine animals, Row planting practices, Row planter

Background and justification

Under intensive cropping, timeliness of operations is one of the most important factors which can only be achieved if appropriate uses of agricultural machines are advocated (Salokhe and Oida, 2003). Increases in crop yield, cropping reliability, cropping frequency and crop returns all depend on the uniform and timely establishment of optimum plant populations. A meaningful selection, setting and management of all farm machinery, especially the planting operation is one of the most important agronomic requirements for optimum plant establishment associated with crop production (Murray *et al*., 2006).

In wheat belt woredas of Arsi and West Arsi, farmers repeat tillage several times to prepare seed bed, usually from 3 to 6 times before plantation. This activity is performed in 90 to 100 days. During months of this operation, there is scarcity of draft animal in the area as well as forage except plant residue. As per information from Zonal BoA, 5 to 10% of farmers face challenge of oxen because of long continuous operation time and inadequate forage availability. To tackle these problems, farmers are practicing the use of equine animals for sowing activities. Since the use of these animals for sowing is being practiced, thus, adapting of improved oxen driven wheat row planter which is proven for effective wheat planting for horse is essential for farmers in this area.

Accordingly, the objective of this activity was to modify and evaluate the proven oxen drawn wheat row planter for horse so that alternative draft power source with improved technology will be availed for the selected area.

Materials and Methods

1) Material used to manufacture prototype

Raw materials used for the manufacturing of prototype technology were angle iron, flat iron, sheet metals, aluminum flutes, $1^{1/2}$, galvanized water pipe, different size bolts and nuts, bearings, beam and handle wood.

2) Parts modified to fit for harnessing system

The following parts of the original planter were modified to decrease the overall weight of planter.

Hopper: It was made up of 1.5mm sheet metal with four compartments. Reducing the overall weight of the technology was mandatory to be pulled by single horse.

Ground wheel: The diameter of the existing wheel was reduced from 60cm dia to 55cm dia which reduces both overall height and weight of the machine.

3) Technology description

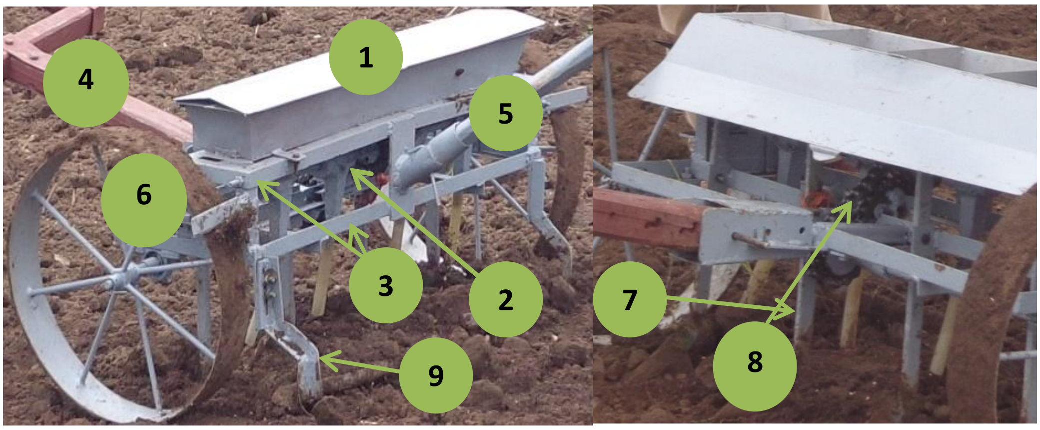


Fig 1: Pictorial description of the planter(*1-hopper, 2-seed metering mechanism, 3-frame, 4-beam, 5-handle, 6-wheel, 7-furrow opener, 8-chain and sprocket assembly, 9-furrow cover)*

Seed box (hopper): is a box like structure made up of steel sheet metal of 1.5mm thickness with four compartments for seed. Seed metering mechanism is placed at the bottom of the box.

Metering mechanism: it picks up seeds from the seed box and delivers them in to the seed tube. It is fluted roller feed type and provided at the bottom of the box. The numbers of fluted rollers are equal to number of rows. The fluted roller is driven by a steel shaft. There are ten horizontal groves provided along the outer periphery of the rollers and rollers can be shifted along the shaft depending upon the seed rate. These rollers are mounted at the bottom of the seed box. They are made of aluminum material with housing of galvanized water pipe.

Frame: Made of mild steel angle section and flats. It is designed in such a way that strong enough to withstand all types of loads in working condition. All other parts of the seed drill are fitted to the frame.

Beam: Made of wood and designed to fit with single animal harnessing mechanism and used to connect the planter with animal.

Wheels: Are fitted on an axle for transporting the drill on roads. Flat iron wheels and or pneumatic tire are used as transport wheels. They are fitted with chain and sprocket attachment to transmit motion of the wheel to the seed metering mechanism when the drill is in operation.

Furrow openers: These are the parts which open up furrows in the soil for placing the seeds. It is shovel structure made up of sheet metal and flat iron.

Covering device or furrow closer: It is a device which closes the furrow with soil after the seed dropped in. The covering device is made in straight bar mode which is connected to frame at the back.

Deriving mechanism: consists of a sprocket-chain assembly and drive and driven shaft that carry the seed picking discs. The chain connects the drive shaft sprocket and the driven shaft sprocket. As the drive shaft rotates with ground wheel, the driven shaft which carries the seed metering discs rotates and picks up seed from hopper.

4) Experimental detail

The experiment was conducted on sandy loam soil in West Arsi zone of Oromia regional state. It was conducted in 2016/17 cropping season. The wheat variety used was kubsa. The experimental farmers were purposively selected. Treatments used to evaluate the technology were local row planting practice, broad casting and row planting with improved technology.The plot size was 20m X 5m replicated three times on similar soil types and conditions. Comparative evaluation was done by selecting the following performance indicator parameters.

Labor Requirement: It is the number of person required on operation/during planting time (in person per operation)

Planting time*:* Time taken for sowing by animal drawn planter and manual hr/ plot

Distribution uniformity*:* Percentage of even distribution of plant /plot. The row spacing and plant population in a row are treated here.

Plant population: It is the number of plants per hectare. The optimal yield is the factor of planmt population.

Depth of planting*:* Depth of the hole was measured by scale ruler (cm)

Yield*:* The wheat harvested from each plot harvested, dried, cleaned and weighted to kg per hectare.

Seed rate*:* Amount of seed required for one hectare planting in kg per hectare

Result and discussion

The mean performance indicator parameters test results of the treatments were explained in the following table.

Table 1: Field performance test results

Treatments	**Seed rate (kg/ha)**	**Field capacity (ha/hr)**	**Operational speed (m/sec)**	**Number of rows per pass**	**Depth of plough(m)**	**Labor required per operation**
Broad casting	152	0.044	0.72	1	0.17	3 men
Local row planting practice	146.5	0.04	0.69	1	0.17	3 men
Improved technology	111	0.17	0.85	4	0.05	3 men

Seed rate: It is the amount of seed to plant one hectare in kg/ha. From the performance result indicated in the above table (Table 1),amount of seed saved per hector by improved technology was 41kg and 35.5kg when compared with broad casting and local row planting methods respectively. Comparing seed rate the improved technology was found superior to both local row planting practice and broad casting methods.

Field capacity:It is the amount of work performed in ha/hr. As indicated in the table;5.88hrs, 25hrs and 22.72hrs were needed to cover one hectare by using improved technology, local row planting practice and broad casting methods respectively.

Working width:It was also compared as 4 rows, 1row and one row for improved technology, local row planting and broad casting respectively. Thus, improved technology drills four rows per single pass while the other methods plants one row per pass.

Depth of planting: Plants as shallow as possible provide seed placed in the moisture zone but deep enough so that the drying front will not reach the seedling roots before leaf emergence. Optimum planting depth for wheat is between 50-70 mm. From test result obtained, the improved technology drills seed within recommended depth range while the local row planting and broad casting ploughs deeper than recommended range.

Operation drudgery: One of the main objectives of engineering technologies is to reduce work drudgery and related hardships to ease intended operation. On operation it was very comfortable for operator to use improved technology while it was painful to use local row planting practice especially, for the one who drops seed and fertilizer in a row. From the comments of farmers and observations, improved technology eases row planting related operational hardships.

The following figures describe population density and distribution uniformity of the treatment data taken during germination count.

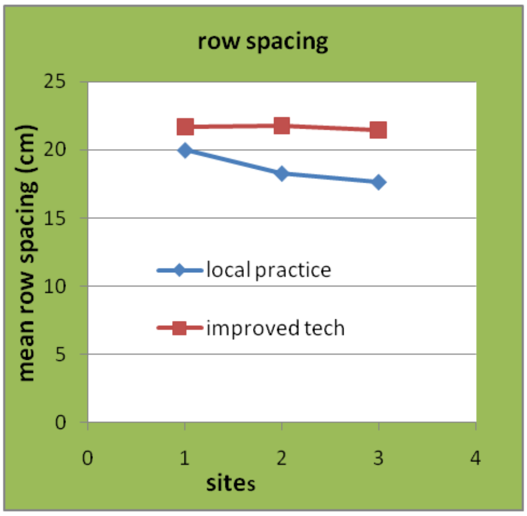


Figure 1: Mean row spacing across sites

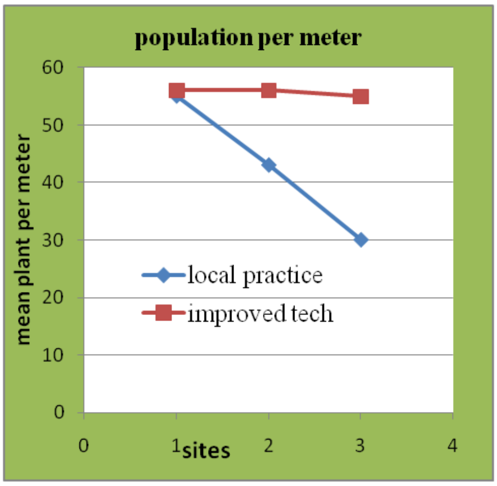


Figure 2: Mean plant population comparison

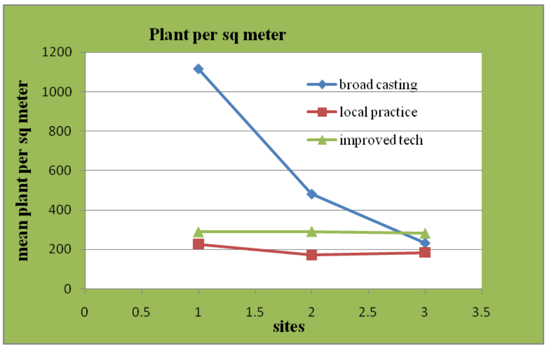


Figure 3: Mean plant population per meter square

The performance results described on Fig 1, 2 and 3 indicate plant population and distribution uniformity. As shown on Figure 1, improved technology line (red) had small variation in mean sample values and that of local row planting technology had relatively larger variation. The ideal row spacing variation is zero, from the variation figure the superior treatment is improved technology. Figure 2 described plant population per meter of the treatments. As revealed on the figure, the mean variation of the samples across site indicated that improved technology performs better than local practice. From the recorded and analyzed data indicated on the same figure, it can be concluded that improved technology performs better than the other two treatments.On figure 3, plant population per square meter was compared. When population density was compared, again the improved technology treatment performs better than the other treatments.

*Distribution uniformity*indicates variation in delivery between openers. The coefficient of variation (CV) is a mathematical term used to describe distribution uniformity.

$$CV = (\text{StDEV sample}) * \frac{100}{\text{Average sample}}$$

Where; CV is Coefficient of Variation

StDEV-is Standard Deviation of Sample data and Average sample is arithmetic average of the sample data taken.

The interpretation of coefficient of variation is as characterized by PAMI (Prairie Agricultural Machinery Institute it is Canadian Company working on machinery research) has accepted the following scale as its basis for rating distribution uniformity of seeding implements for wheat crop:CV greater than 15% -- unacceptable, CV between 10 and 15% -- acceptable, CV less than 10% -- very good and CV less than 5% -- excellent

Table 2: distribution of Coefficient of Variation

	Of all sample	
	Single animal planter	Local practice
StDEV	5.78	6.51
Sample Avg	38.43	34.86
CV (%)	15.04	18.64

The coefficient of variation of the planter is within acceptable range of plant distribution uniformity while that of the local practice is not in the recommended uniformity range.

Grain yield by improved technology was 70.21q per hectare while that of the local practice and broad casting was 68.18q per hectare and 48 q per hectare respectively. Thus, grain yield advantages of 4.03kuntal per hectare compared to local row planting practice was recorded by using improved technology.

Conclusion and Recommendation

The improved single animal row planter improves operation timeliness of row planting, removes work drudgery of the operation, saves seed and shows yield advantages over the other treatments. Work drudgery and operation timeliness are the main objectives for both small or large mechanization technologies and this will facilitate the adoption of row planting practice in the area. Generally, the improved single animal drawn technology had superior advantage over local row planting practice in all selected evaluation parameters. Since time operation is reduced by four folds the cost of operation will also reduce. Thus, it is advantageous to multiply and distribute this technology in the study area.

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