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Adaptation and Improvement of Wheat and Rice Harvester for Small and Mid-level Farmers of Ethiopia

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During harvesting season, often rain and storm cause considerable damage to standing crops. Rapid harvest facilitates extra days for land preparation and earlier planting of the next crop. Thus the use of harvesting machines can help to harvest at proper stage of crop maturity and reduce drudgery and operation time, which also generates spare time for education, social, cultural and political activities and human development especially for women headed household's farmers. So that these type of harvesting machines are crucial to solve the harvesting problems of small and mid-level of farmers. Thus considering the advantage of small and mid-level harvesting machines, this experiment were planned to evaluate the performance of the machines. The experiments were conducted at Ginir and Kulumssa on wheat crop variety name kakaba and digelu and Fogera on Rice crop variety name x-jegena. Three treatments were selected for the performance evaluations were walking behind harvester, brush cutter harvester and manual with sickle. The results indicate that walking behind harvester has 0.23±0.03ha/hr field capacity while brush cutter harvester and manual harvesting using sickle have field capacity 0.035±0.04ha/hr and 0.013±0.07ha/hr respectively on wheat crop. Labour(man-hr per ha) result which include the time taken to harvest the crop and to collect the harvested crop in to one place/ to make a hip of the harvested crop therefore the two machine i.e. using walking behind harvester and brush cutter have taken 7.6 and 29 hr/ha respectively, while, manual harvesting method using sickle has taken 82 hr/ha. The loss of grain for the three treatments were non-significant at 14.02 %(wb) moisture content (mc) of the wheat, it is around 3%. But the mc of the crop drops the total machines losses became much higher beyond the recommendation. It also found that the variety of the crops matters the total machine loss and the overall performance of the harvesters. Generally the performances of the three treatments were lower on rice crop (table-3) than wheat (table-1, and 2).

Key Word: Rice, wheat, vertical reaper harvester, brush cutter and manual harvesting with sickle

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INTRODUCTION

Agriculture is the main stay of Ethiopian economy, contributing 43% share in the GDP and about 83.3% of the population is engaged in agriculture; about 70% of the Ethiopia's industry engaged in processing farm products (MoFD, 2007, 2009). The bulk of agricultural output comes from 13.3million small-scale subsistence households. Each owing, on average, about 0.93ha of land and produces a number of different food and cash crops besides herding livestock (CSA, 2008). Perusing agricultural development strategies & based on lessons drawn from past experience, farmers and pastoralist's production and productivity were enhanced and oriented to focus on productive and commercial crops for domestic & foreign markets; hence its production has

Table 1:-The performance test results of walking behind harvester, brush cutter and manual method using sickle in 2006 E.C. at *Kulumssa* on wheat variety name *Digelu*.

No.	Equipment	Area (ha)	Av. Yield (kg/ha)	Moisture content (%)	Capacity (ha/hr)	Labor (hr/ha)	Speed (Km/hr.)	Width of cut (m)	Loss %	Fuel consumption (l/hr)
`1	Manual with Sickle	0.013	2983.5	14.89	0.013±0.01a	82	0.047	1.05	2.8±0.02a	-
2	Brush cutter harvester	0.013	3142.4	14.22	0.035±0.04b	29	0.26	1.40	3.4±0.05a	0.774
3	Walking behind harvester	0.013	3167.2	14.13	0.23±0.03c	7.6	2.65	1.20	3.2±0.07a	2.46

significantly increased in the last decades. Despite the increase, there are still many problems that are not solved in the production system, among which harvesting techniques seem the first.

As a result, agricultural production process of Ethiopian farmers mainly practiced by small-scale farmers, the harvesting system for many of the crops mainly cutting (uprooting), windrowing, threshing by either beating with stick or treading with animals. These traditional harvesting techniques are labor intensive, time consuming and have a lot of drudgery and cause high losses. For example, during rice production system; studies show that these losses range from 5% up to 50% from the total production. Crops after harvest are mostly transported to the threshing and shelling site; where they are stacked or stored till the threshing or shelling season reach. Thus there is a greater post-harvest loss due to the method being employed (MoAD 2010).

Moreover, during harvesting season, often rain and storm cause considerable damage to standing crops. Rapid harvest facilitates extra days for land preparation and earlier planting of the next crop. Thus the use of harvesting machines can help to harvest at proper stage of crop maturity and reduce drudgery and operation time, which also generates spare time for education, social, cultural and political activities and human development especially for women headed household's farmers. Therefore, this paper is written with the aim of alleviating the existing problem in the harvesting of rice and wheat crops by adaptation of small to mid-level crop harvesting machines.

METHODOLOGY

Walking behind/Vertical reaper/ harvester, Brush cutter and Manual with sickle harvesting method were compared on wheat and rice crop following standard test procedure. Randomized Complete Block Design (RCBD) was used as experimental design with three replications. Data (field capacity (ha/hr), speed of operation (km/hr), width of cut (m), labour(hr/ha), moisture content(%), av. yield(kg/ha), grain loss(%) and fuel consumption(l/hr.)) were collected and analyzed. The sites for the field trial were *Kulumssa*, *Ginir* and *Fogera* in 2006 up to 2008 E.C. crop season.

RESULTS AND DISCUSSION

The results showed that walking behind harvester 17.7 times greater in field capacity than manual harvesting using sickle, and it also found that 6.34 times greater than brush cutter harvester. Labor(man-hr per ha) result which include the time taken to harvest the crop and to collect the harvested crop in to one place/ to make a hip of the harvested crop/ therefore the two machine i.e. using walking behind harvester and brush cutter have taken 7.6 and 29 hr/ha respectively while manual harvesting method using sickle has taken 82 hr/ha. The loss of grain for the three treatments were non-significant, it is around 3%. (Table 1)

As shown on the table 2 and Figure 1, 2 and 3, the walking behind harvester has shown excelled performances in most of the treatments. The brush cutter harvester had clogging problem(the maturity of the standing crop is not uniform and the weed created clogging problem on the rotated disc and also if the moisture content of the crop becomes higher than 14% (wb) the uncut crop becomes higher and higher. Besides this the brush cutter harvester if the width of cut increases above 1meter the engine loss its torque and the crop becomes uncut. And also the operators need to operate the implement holding it closer to the ground and swipe it right and left to cut the standing crop which causes higher drudgery. While manual with sickle method has better performance in in terms of grain loss on two level of moisture content, i.e. 14.02% and 8% (wb).

Table-2: Summary of performance results on wheat crop at Ginir in 2007 and at kulumsa in 2008 E.C.

Major Parameters	Treatments					
	Walking Behind Harvester/VRH/		Brush Cutter(BC)		Manual Harvestering Using Sickle(CH)	
Variety	Kakaba(wheat)		Kakaba(wheat)		Kakaba(wheat)	
Location	Ginir(2007 E.C.)	Kulumsa(2008 E.C.)	Ginir(2007 E.C.)	Kulumsa(2008 E.C.)	Ginir(2007 E.C.)	Kulumsa(2008 E.C.)
Moisture content of the crop, wb %	14.02	8.00	14.02	8.00	14.02	8.00
Duration of test(min)	4.83	9.39	33.22	52.96	74	118
Operating speed , m/s	0.586	0.65	0.072	0.092	0.037	0.036
Effective width of cut, cm	120	112.7	146.6	161.3	120	120
Fuel consumption, l/ha	9.44	7.28	34.8	30.89	NA	NA
Total machine loss,%	3.47	6.06	3.29	6.88	2.43	4.55
Actual field capacity, ha/hr	0.22	0.19	0.033	0.037	0.015	0.015
Theoretical field capacity, ha/hr	0.25	0.25	0.038	0.050	0.0156	0.016
Field efficiency,%	88	76	86.8	74	96.15	96.15
Labor, man-hr/ha	4.5	5.2	30.8	29.4	68.5	65.6

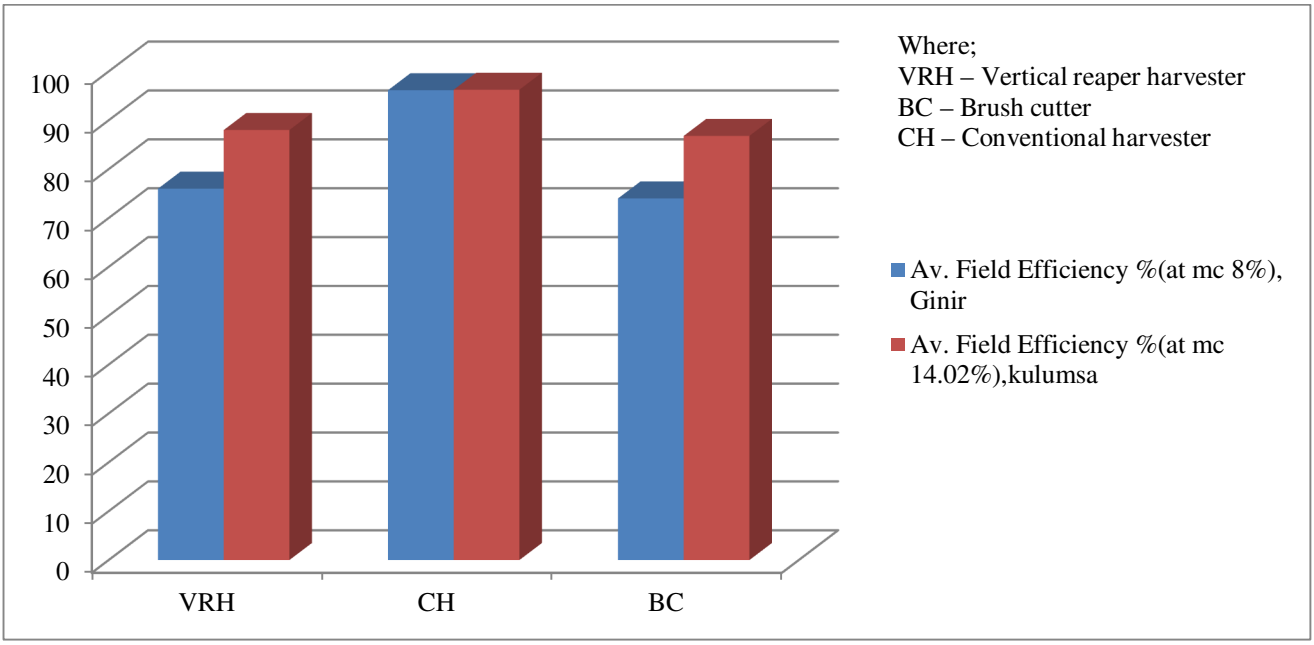

Figure 1: Performance results of field efficiency of walking behind harvester, brush cutter and manual with sickle harvesting method on wheat variety name kakaba.

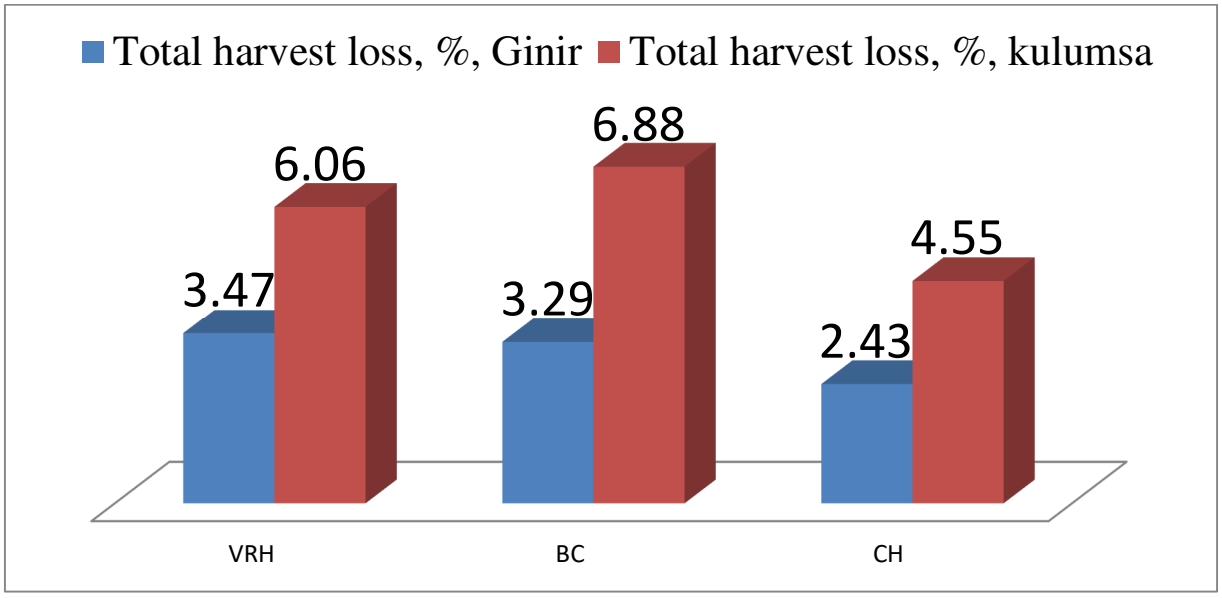

Figure 2: Performance results of total harvest loss of walking behind harvester, brush cutter and manual with sickle harvesting method on wheat variety name kakaba.

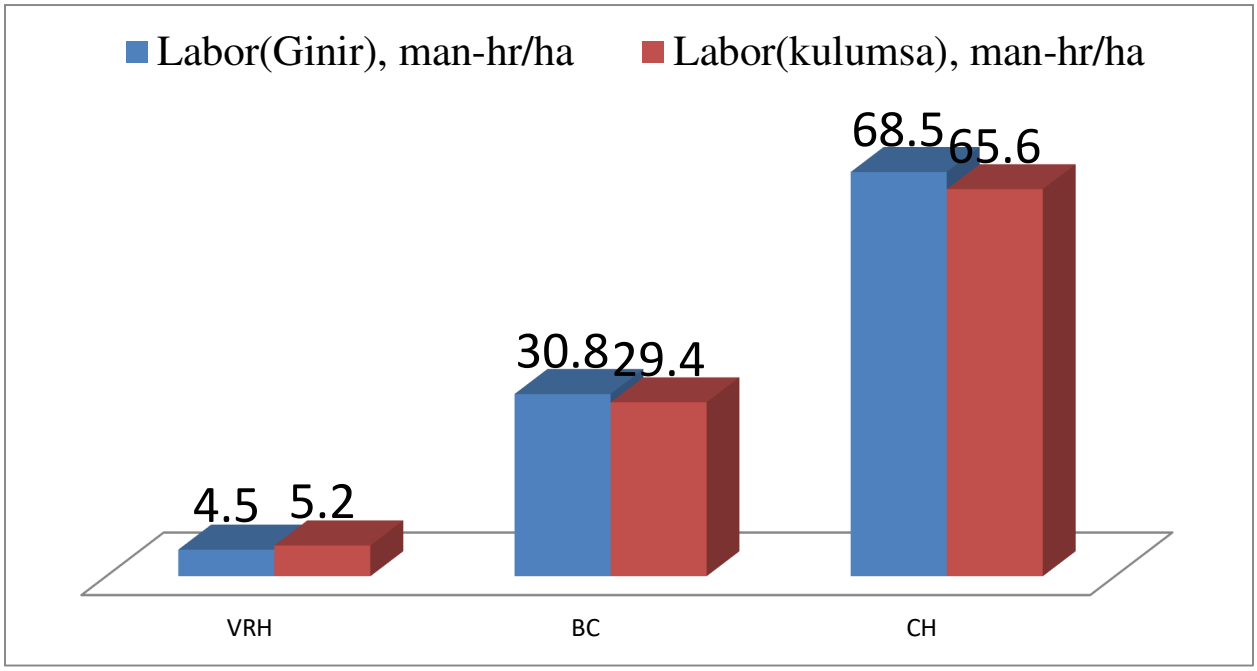

Figure 3: Performance results of required labour of walking behind harvester, brush cutter and manual with sickle harvesting method on wheat variety name kakaba.

Table 3: Summary of Performance results on Rice/Paddy in 2008 E.C.

Major Parameters	Treatments		
	Walking Behind Harvester/VRH/	Brush Cutter(BC)	Manual Harvesting Using Sickle(CH)
Variety	X-Jegena	X-Jegena	X-Jegena
Location	Fogera(2008 E.C.)	Fogera(2008 E.C.)	Fogera(2008 E.C.)
Moisture content of the crop, wb %	17.02	17.6	16.87
Duration of test(min)	9.39	52.96	118
Operating speed , m/s	0.65	0.092	0.036
Effective width of cut, cm	110.7	111.3	120
Fuel consumption, l/ha	10.28	40.89	NA
Total machine loss,%	7.12	6.29	4.95
Actual field capacity, ha/hr	0.16	0.045	0.012
Theoretical field capacity, ha/hr	0.25	0.068	0.016
Field efficiency,%	64	66.17	75
Labor, man-hr/ha	8.2	40.8	85.6

CONCLUSIONS AND RECOMMENDATIONS

- Walking behind harvester excelled in all conditions except the grain losses. Therefore, it is better to use at appropriate maturity stage in order to minimize losses. It has spare parts problems especially the safety pin broken easily during operation. The engine of the walking behind harvester has two fuel compartments for petroleum and kerosene, during starting it uses petroleum while during operating it uses kerosene. So that it is difficult for farmers to understand the difference in torque output and also the valve easily breakable. Due to the spare part problem and the price of the machine is not affordable by individual farmers to use it even if it has the better performance. Instead it is better to use two wheel tractor attached Reaper harvester, it has the same function and the price also much less that self-propelled walking behind harvester.
- The Brush cutter harvester performance was affected by weed intensity and non-uniform crop maturity. While cutting the crop the disc of the harvester clogs easily by weed and wet crop and also sometimes left uncut crop on the field.
- Brush cutter harvester needs some modification on the side trap and on the discs and clutch to get maximum torque during harvesting.

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