Greener Journal of Agricultural Sciences
ISSN: 2276-7770; ICV: 6.15
Vol. 3 (8), pp. 628-636, August 2013

http://gjournals.org/GJAS

Research Article

Performance of Animal Drawn Planter on Establishment and Productivity of Groundnut in North Kordofan of Sudan

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ARTICLE INFO

Article No.: *071013715*
DOI: *10.15580/GJAS.2013.8.071013715*

Submitted: *10/07/2013*
Accepted: *22/08/2013*
Published: *29/08/2013*

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Keywords:
Animal Drawn planter, Sandy Soil, Groundnut Productivity, Establishment, Sudan

ABSTRACT

In Sudan, groundnut is important in terms of area cultivated, oil and cash export crop. However, the labor requirement for field production considered as the main constraint in groundnut cultivation. Field experiments were conducted in three locations namely El-Obeid research station, El-Nuhoud and Elmahana on sandy soil during two consecutive seasons, 2011/2012 and 2012/2013. The objective of experiment was to evaluate the effect of animal drawn planter on establishment and yield of groundnut in sandy soil. In this experiment, two types of sowing methods were used, the animal drawn planter and manual sowing. The animal drawn planter is simple, locally made and easily operated and maintained by farmers. The treatments were arranged in randomize plots with three replicates and analyzed by t-test. The parameters observed were sowing time, plant population, depth of sowing, uniformity %, weeding %, 50% flowering; and yield and hay production. The results showed that there were highly significant differences between the animal drawn planter and manual for a parameters such as time for sowing, sowing depth, plant population, uniformity of seeding, in groundnut cultivation weeding efficiency, seed and hay yield (kg/ha). The animal drawn planter saves sowing time by 86.6 % compared to manual sowing. It also gave better crop establishment, distribution and uniformity of plant population which resulted in higher yield (1583.9hk/ha) than that of manual treatment (998kg/ha). The results of the economic analysis revealed that the animal drawn planter sowing recorded the highest net return and marginal rate of return (922%) compared to manual sowing for groundnut under rain-fed condition in north kordofan state.

INRODUCTION

Throughout the developing world and many developed countries, animals' traction is an inseparable part of agriculture and many countries, particularly in sub-Saharan Africa, the use of work animals for agriculture and rural transport is increasing every year (FAO, 2000).

Animal drawn technology is particularly important to the traditional rain-fed farming in the Sudan and neighboring countries as many experts count. The technology constitute one of the major solutions to low productivity and the expansion of the production area associated with traditional hand tools used by the rural farmers (Mekki and Mohamed 2011), so as to solve the food security problem of the rural farmers. Animal technology appeared to have provided the answer in this regard, especially small-scale farmers. According to Philip *et.al* (1988), the use of animal technology for agricultural practices is potentially useful and is also an appropriate means of improving the efficiency of the traditional farming system. Animal traction would increase crop yield through better and timely cultivation and planting. It would reduce labor requirement per unit area and allow an increase in the area under cultivation. It would also help resolve bottleneck in weeding and reduce the drudgery of manual labor (Hailu, 1990). Despite the potential of animal traction to alleviate seasonal labor shortages, which together with capital shortage are widely considered as primary production constraint in sub–Saharan African farming systems, less than 10% of total cultivated area is cropped using animals (Starkey 1990).

The use of animal drawn planter using donkeys are a low –cost implement and adapt well in dry area (Simalenga and Joubert 1997), it is also suitably modified for sowing and speedy weeding operations for use in light –textured soils (Awadhwal, 1988). As labor cost of account for over 70% of the total cost of production in most farming operations in rural setting (Arene, 1995), the search for an alternative source of farm power which will be cheap and affordable to the farmers therefore, became necessary.

The intermediate technology in the form of animal drawn implement was introduced to En-Nuhoud during 1983 and supported by IFAD in 1989. The technology improved the standard of living of rural population by increasing crop production and decreasing the total cost of cultural practices (ENCCP, 1997).

In Sudan, groundnut is important crop in terms of food uses as oil, cash crop and area under cultivation where the crop is about 0.8 million hectares with an estimated total production of 0.4 million ton (Osman, 2003). The crop is grown under irrigation in the central clay plains and in the rain fed areas in the sandy soils of Western Sudan. About 80% of the area fall under traditional rain fed sector of Western Sudan. This area produces about two third of the national production. In North Kordofan, the area under cultivation in last five years was approximately 1108394feddan, in season 2009/2010 the area was 980089feddan and in season 2010/2011 was 1008022feddan, with average productivity 140kg/fed (MOA, 2012).

According to the nature of the sandy soil which is described as light and therefore is exposed to both wind and water erosion. Animal drawn planter has impact on reduction of time for agricultural operation. The short growing season and the scarcity of labor make high need for the intermediate technology to be used for sandy soil in North Kordofan.

Objectives

1. To evaluate the performance of Donkey drawn planter in sandy soil in North Kordofan of Sudan
2. To study the impact of Donkey planter on establishment and productivity of groundnut in study area.

MATERIALS AND METHODS

Sites Description

Three study areas were selected and classified as sandy soil which covered more than 70% from North Kordofan area, the soil is stabilized sand dunes or sand sheet, which is characterized by deep, homogenous in texture ranged from fine to coarse sand (98% sand) (Osman 2003).

The seasonal rain fall data measured for the trial sites are shown in table (1).

Table (1): Rainfall amount (mm) of the three study areas in North Kordofan

Location	Season 2011/2012	Season 2012/2013
El-Obeid	326.0	448.0
En-Nuhood	450.3	429.9
Elmahana	283.9	493.0

Sources: El-Obeid station and extension offices of Agriculture ministry.

Description of Animal Drawn Planter

It's simple, handmade with total weight of the 38kg and 0.50m width, made of iron. It consists of ten main parts (Picture1); 1. Seeder box with 12kg seed capacity. 2. Draw pars. 3. Carrying frame. 4. Two ground wheels (55cm diameter). 5. Seed plate (diameter 18cm and 17 pores). 6. Driven sprocket. 7. Seed tubes. 8. Furrow opener. 9. Presser tool; and 10. Weed cultivator and marker.

Picture (1) the animal drawn planter

The Planter Field Testing

For assessment of animal drawn planter, two treatments were used which are described below:

1. Donkey drawn planter (required two labor, one for guiding the animal and other to control the movement in the row)
2. Manual (required two labors, one for digging the hole by hoe and other man for sowing).

Then the experiments were designed and conducted in the sandy soils field. Randomize complete plot with three replications were used with plot size of 20x5m^2 and 8 rows. Groundnut released variety Sodari was selected and examined using the recommended cultural practices in Sudan.

Weeding Operations

One weeding was done for animal planter (after 2 weeks of sowing) and two weeding were done for the manual treatment (as recommended by ARC).

DATA COLLECTION AND STATISTICAL ANALYSIS

The data were collected from the parameters as described below:

1. Planting time: The time taken for sowing by animal drawn planter and manual hr/ plot
2. Plant population: The number of plants in plot area;

    1. Depth of planting: The depth of the hole was measured by ruler (cm)
    2. Weeding: The percentage of removed weed in 1m^2
    3. Uniformity: The percentage of even distribution of plant /plot
    4. Days to 50% Plant Flowering: The number of days from plant emergence until plants were having at least one flower was counted.
    5. Yield: The pods of groundnut per unit area of each plot were harvested, dried, cleaned and weighted then adjusted to kg per hectare.
    6. Hay: The harvested plant dried and weighed then adjusted to kg per hectare.

7. Statistical analysis: MSTAT-C statistical package was utilized to analyze the data by t- test method
8. Economic analysis (Partial budgeting techniques. CIMMYT, 1988)

RESULTS AND DISCUSSIONS

The Time of Sowing Operations

The time for agricultural operations, especially the time for sowing is most crucial in short rainy seasons of dry land. Individual analysis of time for sowing results showed highly significant difference between the tested treatments (Tables 2-7) in all locations for the two seasons. The calculated time to sow one hectare by animal drawn planter was 4.9hr, while it was 36.6 hr for manual sowing. This means that the donkey drawn planter was speedy compared to manual sowing thus saving the time six times over the manual sowing, similar result was obtained by Philip et al. (1988). The time reduction of planting was obtained in all locations during the two seasons under planter treatments; this may be due to the sandy soil of these locations that facilitate the action of the planter as (Awadhwal, 1988) who reported that donkey drawn planter is used in light texture soil.

Depth of Sowing

The action of donkey drawn planter showed a significant difference with manual labor in the depth of sowing. Although the manual labor placed the seed deeper (9cm) than planter (6.1cm), but the light depth gives more benefit as revealed by uniformity and plant population from field observations, the birds (crow) follow the dug holes of manual labor and severely eat all seeds. The locations showed differences in the depth of sowing between planter and manual and this is due to difference in moisture of soil during the two seasons (Tables 2-7).

Plant Population

The donkey drawn planter treatments give higher plant population than manual (Tables 4 and 5), and this is because of no missing holes and the uniformity of planting operations. This result showed the accuracy of the donkey drawn planter which had not been standardized by thinning. Similar result was obtained by Scheidtweiler (1999) who got high populations when he used animal-drawn punch planters.

Weeding%

The weeding efficiency showed a significant variation between planter and manual treatments (Tables 2-7). The higher percentage, 91.6% was obtained from planter whereas manual labor showed 73.5%, this is due to the presence of weeding units that added to the planter which reduce the population of weeds. Same result was obtained by Hailu (1990).

Uniformity%

There is a significant variation between planter and manual treatments on operations of plant uniformity (Tables 2-5). The higher uniformity, 94 % was obtained from planter compared to lower (69.7%) which was obtained from manual. This is due to adjustability of the planter in operations, similar study by Philip et al. (1998) showed that animal traction would increase yield through timely cultivation and planting.

Yield (Kg/Ha)

Animal technology constitutes one of the major solutions to low productivity that is associated with traditional hand tools by rural farmers. The t-test analysis for the three locations and two seasons showed significant variation in yield (Tables 2-7). The average higher yield was obtained from donkey drawn planter (1584kg/ha) across the two seasons and three locations compared to the manual labor which is (998kg/ha). The increment in yield was 58.8% and this is due to uniformity of planting which resulted in more plant population beside the reduction of weeds competition in moisture. Similar results were obtained by investigators when using animal drawn planter (Hailu, 1990; Starkey, 1990).

HAY PRODUCTION

Significant variation between donkey drawn planer and manual treatments were found in the three locations and the two seasons as revealed by the result of the t- test (Tables 2-7). The higher production of hay was produced from animal drawn planter treatments (2055.8kg/ha) and lower (1570.8kg/ha) from manual treatment . The two superior locations (En-Nuhood and Elmahana) in hay production characterized by high plant population that resulted in higher yield which largely depends on pattern of rainfall distribution and amount (El-Awad, 1988).

ECONOMICAL ANALYSIS

The results of the economic analysis revealed that the donkey drawn planter sowing had the highest net return and marginal rate of return (922%) compared to manual sowing for groundnut under rain-fed condition in North Kordofan state (Table 8). The sowing by animal drawn planter is better than manual sowing and investment on donkey drawn planter produced a marginal rate of return (MRR) of about 922% (Table 9). This indicates that every

monetary unit (SDP 1) invested in animal drawn planter would be returned back, plus an additional amount of SDP 9.22.

CONCLUSION

We conclude that the donkey drawn planter is more suitable for sowing groundnut in sandy soils in North Kordofan state. Also, it significantly reduced the sowing time and increased groundnut yield compared to manual sowing. Moreover, the planter scored higher net return and marginal rate of return compared to manual sowing under rain-fed condition in North Kordofan state.

Table (2): Effect of donkey drawn planter and manual sowing on groundnut performance and yield in El-Obeid, season 2011/2012

	Time of planting (hr/ha)	Plant population/ha	Depth of planting (cm)	Weeding (%)	Uniform%	50% Flowering	Yield (Kg/ha)	Hay (Kg/ha)
Animal planter	4.40	111554	6.7	95	98	26	765	932
Manual	31.9	103746	9.3	75	78	26	628	771
SE±	2.50	2119.4	0.33	5.8	5.77	1	3.38	14.2
T value	-10.9	3.68	-8.0	3.46	3.46	0	40.59	11.3
Level of significant	***	Ns	*	Ns	ns	ns	***	**

Note: *, **, *** and ns = significant at 0.05, 0.01, 0.001 and not significant, respectively.

Table (4): Effect of donkey drawn planter and Manual on Groundnut Yield in En-Nuhoud Season 2011/2012

	Time of planting hr/ha	Plant population/ha	Depth of planting	Weeding %	Uniform %	50% Flowering	Yield Kg/ha	Hay Kg/ha
Animal planter	6.0	124374	6	92	100	27	2667	2833
Manual	34.4	113774	8	75	70	28	1433	2333
SE±	0.87	305.3	1.0	3.33	10.0	0.67	66.7	288
T value	-32.8	43.7	-2.0	5.00	3.0	-2.0	18.5	1.7
Level of significant	***	***	ns	*	ns	ns	**	Ns

Note: *, **, *** and ns = significant at 0.05, 0.01, 0.001 and not significant, respectively.

Table (6): Effect of Animal planter and Manual on Groundnut Yield in Elmahana Season 2011/2012

	Time of planting Hr/ha	Plant population/ha	Depth of planting	Weeding %	Uniform%	50% Flowering	Yield Kg/ha	Hay Kg/ha
Animal planter	4.5	99228	5.7	81	85	27	1621	1890
Manual	36.3	92953	8	58	32	27	1251	1408
SE±	1.6	2757	0.33	3.0	6.7	1.7	81.9	78.6
T- value	-19.6	2.27	-7.0	7.7	8.0	0.2	4.5	6.1
Level of significant	**	Ns	*	*	*	Ns	*	*

Note: *, **, *** and ns = significant at 0.05, 0.01, 0.001 and not significant, respectively

Table (3): Effect of donkey drawn planter and manual sowing on Groundnut Yield in El-Obeid Season 2012/2013

	Time of planting hr/ha	Plant population/ ha	Depth of planting	Weeding %	Uniform%	50 %Flowering	Yield Kg/ha	Hay Kg/ha
Animal planter	3.7	109237	6	99	99	26	1191	1252
Manual	31.4	94524	9	73	83	27	820	1079
SE±	0.88	4392	1.0	2.3	2.3	0.88	60.6	83.1
T-value	-31.5	3.3	-3.0	11	6.7	-o.37	6.04	2.08
Level of significant	***	ns	Ns	**	*	ns	*	ns

Note: *, **and ns = significant at 0.05, 0.01and not significant, respectively.

Table (5): Effect of Planter and Manual on Groundnut Yield in En-Nuhoud Season 2012/2013

	Time of planting Hr/ha	Plant population/ha	Depth of planting	Weeding %	Uniform%	50% Flowering	Yield Kg/ha	Hay Kg/ha
Animal planter	6.0	114133	6	95	101	27	1333	3066
Manual	27.0	88666	9	75	73	26	800	2466
SE±	1.04	5858	0.58	5	4.4	4.04	120	57.7
T-value	-20.3	4.34	-5.2	4	6.4	0.25	4.43	10.4
Level of significant	**	*	*	ns	*	ns	*	**

Note: *, **, ** and ns = significant at 0.05, 0.01, 0.001 and not significant, respectively.

Table (8): Partial budget analysis of the effect of donkey drawn planter and manual sowing on the establishment and yield of groundnut

Treatment	Adjusted Yield (Kg/ha)	Adjusted Hay (Kg/ha)	Gross return SDP/ha	Variable cost SDP/ha	Net return SDP/ha
Manual	801	1257	3466	825	2641
Planter	1266	1645	5342	597	4745

Table (9): Marginal analysis on the effect of donkey drawn planter and manual sowing on the establishment and yield of groundnut

Treatment	Adjusted Yield (Kg/ha)	Gross return SDP/ha	Variable cost SDP/ha	Net return SDP/ha	MC	MNB	MRR
Manual	801	3466	825	2641			
Planter	1266	5342	597	4745	228	2104	922

Table (7): Effect of Animal planter and Manual on Groundnut Yield in Elmahana Season2012/2013

	Time of planting Hr/ha	Plant population/ha	Depth of planting	Weeding %	Uniformity %	50% Flowering	Yield Kg/ha	Hay Kg/ha
Animal planter	5	112355	6	88.	88.	28	1926.	2362
Manual	34.8	91249	11	75	58.	27	1055	1368
SE±	2.23	6571	0.57	1.67	5	1	108	195
T value	-13.4	3.2	-8.7	8	6	1	8.04	5.09
Level of	**	ns	*	*	*	ns	*	*

Note: *, **, *** and ns = significant at 0.05, 0.01, 0.001 and not significant, respectively.

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Cite this Article: Tarig EA, Sawsan KEH, Mohamoud AM, Yasir EA and Salih EE (2013). Performance of Animal Drawn Planter on Establishment and Productivity of Groundnut in North Kordofan of Sudan**.** Greener Journal of Agricultural Sciences, 3(8): 628-636, http://doi.org/10.15580/GJAS.2013.8.071013715**.**