



Research Article

Volume 9 Issue 3 - August 2017
DOI: 10.19080/ARTOAJ.2017.09.555763

Agri Res & Tech: Open Access J

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Determination of Plant Density on Groundnut (*Arachis hypogaea* L.) Intercropped with Sorghum (*Sorghum Bicolor* L. Moench) at Fadis and Erer of Eastern Hararghe Zone



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Submission: June 08, 2017; Published: August 10, 2017

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Abstract

In eastern part of Ethiopia groundnut is very commonly intercropped with sorghum. Even though intercropping of sorghum with groundnut is practiced in the eastern part of Ethiopia the population density at what ratio should not be known. Therefore determining the population ratio is found to be crucial to draw management options. The study was conducted at two locations at Fadis (on station) and Babile (sub-station). Sorghum variety (Teshale) and groundnut (Fetene) were used as planting materials. All agronomic data were collected and analyzed by using GenStat software. Significant differences were obtained among the treatments. The research result showed that, there were significant differences for both sorghum and ground nut yield per hectare in the years (2014 and 2015) among treatments. The result over time (in 2014 and 2015) at Fadis and Erer showed that the highest sorghum and groundnut yield per hectare were obtained/harvested from the intra row spacing of 25cmx20cm and 30cmx20cm intercropping sorghum with ground nut system with (1.27 and 1.31) respectively. The highest LER (1.31) and highest GMV (10218.00 ETBr/ha) were obtained from the intercropping of 30cmx20cm (Sorghum & groundnut). Clearly showed that, with intercropping of sorghum and Groundnut, it is possible to produce additional yield of sorghum without significant reduction in groundnut yield. As a result of this, the intra spacing of the main crop (sorghum) 25cm and 30cm and for the subsidiary crop (groundnut) 20cm was recommended for further production in the study areas of eastern Hararghe zone and similar agro-ecologies [1].

Keywords: Intra row spacing; Intercropping; Land equivalent ratio; Sorghum (Teshale); Groundnut (Fetene)

Introduction

Agete Jerena 2008 defined intercropping as the growing of two or more crops simultaneously in the same field, thus resulting in crop intensification in time and space [2]. Multiple cropping systems are major components of African agriculture accustomed from the consequence of shifting cultivation. There are four types of intercropping as stated by Agete Jerenaat 2008:

- a. Mixed intercropping: growing two or more crops simultaneously without distinct row management; this is commonly used in labor-intensive subsistent farming;
- b. Row intercropping: growing two or more crops together where the component crops occupy different rows;
- c. Strip intercropping: growing more than one crop in the

same field where the component crops occupy different strips to permit the independent cultivation of crops; and

- d. Relay cropping: two different crops are grown in relay, such that part of the growth cycles of component crop overlap.

Among the different types of intercropping mixed broadcasting is a standard system of crop production practice by small holder farmers in Ethiopia [3]. The nature of crop species utilized varies from place to place depending upon environmental and sociological factors. For instance, chat/maize, chat/sorghum, chat/sweet potato, sorghum/legumes, maize/sorghum/bean, etc are the common types of intercropping in Hararghe region Dachassa 2005.

There are two types of intercropping systems (designs) namely additive and substitutive or replacement. Kruger 2003. The base for such type of classification was entirely on plant population density [4]. In additive design the monoculture is constructed by substituting the like species for all positions where the other species occurs in the intercrop or intercrops are added to the optimum population of main crop whereas, in replacement designs the monoculture is constructed by simply removing one of the species from the intercrop or optimum populations of main crops are replaced by intercrops Vandermeer 1989. In intercropping it is worthy to find out the optimum plant density to draw maximum benefit from the intercropping system Billore 1992 [5]. In research conducted on sorghum/groundnut with different plant densities of groundnut revealed that planting 100% sorghum and 50% groundnut resulted in highest total yield than the lowest and highest densities of 100% sorghum, 25% groundnut and 100% sorghum, 75% groundnut respectively showing that plant density is crucial in crop production Billore 1992. In Africa and, India groundnut is very commonly intercropped with sorghum. Some reports have emphasized that significant yield reductions of groundnuts have been obtained when they have been intercropped with sorghum.

Even though intercropping of sorghum with groundnut is practiced in the eastern part of Ethiopia the population density at what ratio should not be known. Therefore determining the population ratio is found to be crucial to draw management options. Hence the present study was conducted to evaluate and promote appropriate plant densities of groundnut intercropping with sorghum at Fadis and Babile (Erer) which is located at eastern part of Ethiopia.

Literature Review

Intercropping

Intercropping was an age old practice of growing simultaneously two or more crops on the same piece of land. Intercropping is mainly practiced to cover the risk of failure of one of the crops due to vagaries of weather or pest and disease incidence. Intercropping may also lead to increased production per unit area per unit time without affecting the yield of main crop to a greater extent. When legumes are used as intercrops, they provide the beneficial effect on soil fertility by fixing atmospheric nitrogen [6-10].

In intercropping system yields, of component crops are not simply added. This is because yield of different crops cannot simply be added together or compared directly with each other, special methods have to be used (Reddy 1990) [11-13]. There are many different methods for assessing output yield advantages from intercrops yields. Among the methods, the first was comparing component yields with their sole crop yield for every crop in the mixture and add the ratios together. Another possibility method is to compare the land area needed to obtain similar component yields in sole and intercrops Reddy 1990.

The aim of legume-cereal intercropping in the cropping systems is to optimize the use of spatial, temporal and physical resources both above and below ground, by maximizing positive interactions and minimizing negative ones among the components N dakidemi 2006.

It is well known that weeds are among the major crop production constraints. The growing of companion crops in close proximity to one another in intercropping provides greater plant density than sole crops and this should result in greater competition against weeds Moody and Shetty 1981. Proper weed control is crucial in enhancing crop productivity in a given unit of area Aleman 2000. Liebman and Dick 1993 stated that weed suppression is greater with intercropping than in a single crop [14].

Soil fertility

It is possible to maintain soil fertility under continuous cultivation through intercropping legume with cereals. In order to maintain soil fertility under continuous cultivation in SSA, the soil N content need to be increased [15,16]. To have high N level the traditional farming system should be modified in a way that satisfies the economic need of the farmer and also improving the soil N requirements. Reports on the results of intercropping for soil fertility management revealed that the contribution of legumes root to the soil N level ranges from 5 to 15kg/ha Nnadi and Haque 1986.

Soils obtain nitrogen from different sources but much is derived from N-fixed by legumes, which has greater potential and cheapest sources as well. Biologically fixed N is transformed into leguminous protein and this may be consumed directly by animals to meet their protein requirements and excess return to soil through manure, hence, legumes are crucial to maintaining the N-balance in nature Gutteridge and Shelton 1994. Legumes are universally known for their ability to fix chemically inactive atmospheric nitrogen to satisfy their nitrogen requirements. They achieve this through symbiotic relationship with N-fixing Rhizobium bacteria, which is found in nodules of their roots Nnadi and Haque 1986.

Agronomic importance of intercropping

Planting pattern influences both yield of sorghum as well as that of groundnut. In research conducted on millet/stylo intercropping, average millet grain yield from the alternate triple row millet/Stylo santheshamata treatment decreased by 78% as compared with sole plots millet yield. Millet stover yields were 10-53% less from intercrops than sole crops. When millet was grown with S hamatain alternate triple rows, total biomass yield decreased by 40 to 49% Kuoame et al. [17].

Yield stability

Intercropping is not the only mechanism to increase the yield of component crops. Apart ecological and socio-economic

aspects, the main advantage of intercropping is yield stability, which is reliable food and feed production over the years. In reality, intercropping systems give more stable yields than sole cropping system. This is one of the main reasons why farmers still prefer mixed cropping Altieri 1998. There were many reasons behind the stability of yield in mixed cropping than mono crop. One of the basic principles was compensation when one component crop suffers from drought, pests and diseases, does not develop properly; the loss of this crop is compensated at least partly by the other component crop (s), since there is low less compared with sole cropping Willey 1979.

Assessing intercropping yield advantage

There are different intercropping situations that satisfied different requirements of yield advantages. Willey identified three distinct situations to assess the yield advantage more precisely and to plan intercropping research with relevant rationale. In the first place, intercropping must give full yield of the main crop and some yield of the associated crop. More specifically, main crop gives full yield and in addition there is associated crop that gives extra yield reducing the principal crop yield. This situation is applicable where the promising requirement is for a full yield of some staple food crops [18].

The second situation is the higher sole crop yield is lower than the intercrop yield. In this intercropping requirement, the combined yield of the component crops must be exceed the yield of either of the sole crops, particularly the yield of the intercrop that gives higher in monoculture. It is based on the assumption that gives unit yield of each crop component crops is simply for maximum yield regardless of the crop from which it comes. The third situation is combined intercrop yield must exceed a combined sole crop yield. This criterion is based on the assumption that producers usually needs to grow more than one crop; which is aimed at satisfying food requirements, spreading labor peaks and to guard against risks.

In research conducted to identify chemical composition and best cropping system of groundnut and sorghum under mixed and mono crop, it was found out that the sorghum fodder yields were lower in the mono crop and even less in the mixed crops. Among crops in association there were competitions between them. The degree of competition between mixed crops is determined by plant populations and intercropping patterns. Intercrops may be sown in alternate hills within rows, alternate rows, paired rows or strips of more than two rows Shehu et al. 1999. In general, when plants are in closer contacts due to type of intercropping patterns used, the competition among plants will be higher. The opportunities for sharing resource are greatest when two crops are planted in alternate hills within rows or are broadcasted rather than sown in rows, and the closed proximity of the crops can also lead to more direct competition between intercrops Ibrahim et al. 1993.

Inter cropping also has an agronomic advantages of rising, ambient temperature that limits the chance of frost damage, and increase protection of the ground against sunlight and impact of high-intensity raindrops, so that erosion is impeded Humphreys, 1994. Inter cropping also has a role in increasing the quality of grains of the main crops. In experiment conducted at Debre Zeit, Ethiopia, higher nitrogen content in maize grain when intercropped with vetch was obtained Nnadi and Haque 1986 [19].

Material and Methods

Description of experimental site

The study was conducted under rain fed conditions at Fedis Agricultural Research Center of Oromia Agricultural Research Institute (OARI) at Boko sub-site, which is located at the latitude of 9° 07' north and longitude of 42° 04' east, in the middle and lowland areas and at the altitude of 1702 meters above sea level, with a prevalence of lowlands. The area is situated at the distance of about 24km from Harari town in the southerly direction.

Table 1: The means interaction over location effect of yield and yield parameters of ground nut intercropped with sorghum at Fadis and Erer in 2014.

Sorghum Spacing	Panicle Length	P/ Diameter	Yield kg/haSR	Ppp	Spp	Yield kg/ha GRN	LR
25	22.73	8.73	2212.33	39	2.13	1844.66	1.12
30	22.02	9.13	2468.66	29.67	2.2	1767	1.01
35	22.63	9.1	2237	29.67	2.06	1682.67	1.01
CV%	7	12.4	13.9	25.4	20.5	23	24.6
LSD(5%)	2.9	1.8	226.4	0.78	0.11	153	0.31
P<0.05	NS	NS	*	NS	*	*	NS
Ground nut spacing							
15	22.73	8.77	2364.67	34	2.07	1620.33	1.12
20	22.37	9.2	2422	35.33	2.23	2056	1.43
25	22.47	9	2072	29	2.1	1578	0.9
CV%	80	12	14	22	17	21	22
LSD (5%)	2.28	1.8	223	0.7	0.12	152	0.42

P<0.05	NS	NS	*	*	*	*	*
Cropping System	23.8	9.25	2890	26.2	2.2	1363	0.75
Sole Cropping							
Intercropping	22.49	8.79	2296.11	32.78	2.13	1758.11	1.1
CV%	6.9	11	12	21	16	19	19
LSD (5%)	2.43	0.3	226	0.8	0.01	145	0.41
P<0.05	NS	NS	*	*	*	*	*

The soil of the experimental site is black with surface soil texture of sand clay loam that contains 8.20% organic matter; 0.13% total nitrogen, available phosphorus of 4.99ppm, soil exchangeable potassium of 1.68 cmol(+)/kg and a pH value of 8.26 (Table 1). The experimental area is characterized as lowland climate. The mean rainfall is about 860.4mm for the last

five years. The rainfall has a bimodal distribution pattern with heavy rains from April to June and long and erratic rains from August to October. The mean maximum and minimum annual temperature are 27.7 and 11.3 °C, respectively, for the last five years (Fedis Agriculture Research Center Metrological Station) (Appendix Table 2).

Table 2: The means effect of yield and yield parameters of ground nut intercropped with sorghum at Fadis in the years of 2014 &2015.

Treatment (SRG*GNDN)	2014							2015						
	PL	PD	Ppp	SPP	KghS	KghG	LER	PL	PD	Ppp	SPP	KghS	KghG	LER
25X15	24	7.1	37.1ab	2.3	2508a	1506b	0.91b	23.67	9.7	35ab	3.0a	1939bc	1081	0.95bc
25X20	23.8	7.7	45.0a	2.3	2974a	2511a	1.27a	21.67	8.3	34ab	2.8abc	2501b	1017	1.1ab
25X25	23.6	8	43.6a	2.3	1869b	1442b	0.79b	24	10	30ab	2.5c	2228c	667	0.9c
30X15	23.3	7.9	45.3a	2.3	2289a	1553b	0.89b	21.67	8.3	36ab	2.8abc	1851d	1172a	0.94bc
30X20	24.5	8.7	33.0b	2.7	2865a	2729a	1.31a	23.33	8.7	32ab	2.9ab	2531b	1058	1.12a
30X25	24.4	8.6	31.7b	2.7	2839a	1311b	0.95b	23	8.7	47a	3.0a	1646d	911	0.8c
35X15	24.3	7.9	36.1b	2	2142a	1707b	0.89b	24	9.7	32ab	2.9ab	2129c	703	0.88c
35X20	22.2	8	41.2ab	2.3	2386a	1495b	0.88b	23	9.7	29b	2.6bc	1978cd	886	0.9c
35X25	23.7	7.9	28.0b	2.3	1851b	1339b	0.73b	23.33	9.3	39ab	2.7abc	1719cd	950	0.83c
SoleGrnt	-	-	35.4b	1.7	-	1360	-	-	-	36ab	2.9	3017a	925	-
SoleSrg	24.9	7.8	-	-	2919	-	-	32	7.8	-	-	2919	-	-
Cv%	7.7	11	27.3	24	23.8	13.7	-	6	13	25.9	6.6	13.4	30.2	-
LSD (5%)	3.19	1.6	17.9	1	992.5	413.2	-	2.39	2.2	15.63	0.323	473	490.7	-
P<0.05	NS	NS	*	NS	*	*	*	NS	NS	*	*	*	NS	-

Description of experimental materials

Sorghum variety (Teshale) and groundnut (Fetene) were used as planting materials. The seeds were collected from Melkassa Agricultural Research Center. The intra-row spacing for sorghum was 25cm, 30cm and 35cm and that of groundnut was 10cm, 15cm and 20cm. The row spacing was 60cm and 60cm for groundnut and sorghum, respectively. Groundnut and sorghum was planted solely at 60cm x 10cm and 60cm x 20cm for groundnut and sorghum respectively, to compare with the intercropping. Two rows of groundnut separated from each other by 60cm were planted between the sorghum rows, at 40cm away from sorghum rows [20,21].

Treatments Number Sorghum X Groundnut

T1	25cm x 10cm
T2	25cm x 15cm
T3	25cm x 20cm
T4	30cm x 10cm
T5	30cm x 15cm
T6	30cm x 20cm
T7	35cm x 10cm
T8	35cm x 15cm

The treatments were arranged as follows:

T9	35cm x 20cm
T10	Groundnut sole cropping
T11	Sorghum sole cropping

Treatments and Experimental Design

The treatments consisted of three intra rows spacing of sorghum (25cm, 30cm, 35cm) intercropping with intra row spacing (10cm, 15cm, 20cm) of groundnut. The experiment was laid out as a randomized complete block design (RCBD) in a factorial arrangement with three replications per treatment. Each treatment combination was assigned randomly to experimental units within a block. The gross plot size was 4mx3m and net plot size of 12m x 9.36m. Plants in the middle rows were considered for recording data. Plants on the border rows as well as those at both ends of each row were not used for data recording to avoid edge effects [22].

Researchers have designed different indices for assessing intercrop performance as compared to pure stand yield Eyob Kasah 2007. These include comparisons of absolute yield, protein yield, multiple cropping indexes, diversity index, and in economic terms, gross returns from intercrop and sole crop. In research trials, the researchers' mixture and pure stand in separate plots. Yields from the pure stands, and from each separate crop from within the mixture, are measured. From these yields, an assessment of the land requirements per unit of yield can be determined. This information tells them the yield advantage the intercrop has over the pure stand, if any. They then know how much additional yield is required in the pure stand to equal the amount of yield achieved in the intercrop [23]. LER could be used either as an index of biological efficiency to evaluate the effects of various agronomic variable (e.g. Fertility levels, density and spacing, comparison of cultivars performance, relative time of sowing, and combinations) on an intercrop system in a locality or as an index of productivity across geographical locations to compare a variety of intercrop systems (Chetty and Reddy, 1980). LER is defined as the relative land area under sole crops that is required to produce the yield achieved in inter cropping (Ofori and Stern, 1987; Pookpakdi, 1988). It can be expressed as:

$$LER = Y_{ij} / Y_{ii} + Y_{ij} / Y_{jj}$$

Where: Y is the yield per unit area; Y_{ij} and Y_{ji} are intercrop yields of the component crops, i and j, and Y_{ii} and Y_{jj} are sole crop yields. The partial LER value, L_i and L_j , represent the ratios of the yields of crops i and j when grown as intercrops, relative to sole crops and can be expressed as:

$$L_i = (Y_{ij} / Y_{ii}) \text{ and } L_j = (Y_{ij} / Y_{jj})$$

LER is the sum of the two partial land equivalent ratios so that; $LER = L_i + L_j$

When LER measures 1.0, it tells us that the amount of land required for plant 'i' and plant 'j' grow together is the same as that for the plant 'i' and 'j' in pure stand (i.e., there was no advantage

to intercropping over pure stand). When $LER > 1$, a large area of land is needed to produce the same yield of sole crop of each component than with an intercropping mixture.

For example, an LER of 1.25 implies that the yield produced in the total intercrop would have required 25% more land if planted in pure stands. LER below 1.0 shows a disadvantage to intercropping. For example, if the LER was 0.75, then we know the intercrop yield was only 75% of that of the same amount of land that grow pure stands. LER gives an accurate assessment of the biological efficiency of intercropping and this is a useful tool in research. It is, however, important to present actual yields along with LER is in reporting the results of intercropping studies Palaniappan 1985. Generally, the value of LER is determined by several factors including density and competitive ability of the component crop in mixture, crop morphology and duration, and management variables that affect individual crop species.

It has been suggested that in density studies of cereal-legume intercrop systems, the sole crop yield used as standardization factor for estimating LER should be at the optimum density of the crop [24] IRRI, 1974. This avoids the confounding of beneficial interactions between components with a response to change in densities. The values of LER follow the density of the legume component rather than that of the cereal Ofori and Stren, 2987. Differences in competitive ability affect the relative performance of component crop and thus the LER value of different cereal-legume intercrop systems. LER value > 1.00 indicates an agronomic advantage of intercropping over sole cropping.

Economical advantage was assessed using gross monetary values (GMV) to evaluate the economic advantage of intercropping as compared to sole cropping (Willey, 1979). The monetary advantage was determined by the existing local market price.

Monitory Value (MA) = Value of combined intercrop yield x LER-1LER.

To calculate the GMV of component crops, sorghum grain price of 1700 Ethiopian Birr (ETB) per quintal and the price of Groundnut seed per quintal (unshelled) was: 2000 ETB at local flea-market.

Result and Discussion

One of the most important reasons for intercropping is to ensure that an increased and diverse productivity per unit area is obtained compared to sole cropping Sullivan, 2003. For instance using Land Equivalent Ratio in a maize soybean intercropping system, Kipkemoi 2001 reported that it was greater than one under intercrop. Raji 2007 had also reported of higher production efficiency maize-soybean intercropping systems. Addo-Quaye 2011 found that Land Equivalent Ratio was greater than unity, implying that it will be more productive to intercrop maize-soybean than grow them in monoculture [25]. Abera 2005 observed that the LER values ranges from 1.15 to 1.42 indicating

more productivity and land use efficiency of maize (*Zea-mays*)-climbing bean (*Phaseolus vulgaris*) intercropping in terms of food production per unit area than separate planting.

Panicle diameter

The analysis variance revealed that panicle diameter was not significantly affected due to main crop of sorghum population and subsidiary crop ground nut population. Also panicle diameter capacity was no significant due to main effect of sorghum population and groundnut population at Erer location. This might be similar variety are similar responsible for panicle diameter, even if the population of sorghum and intercropped groundnut increases or decreases.

Panicle length

The analysis of variance revealed that panicle length was not significantly affected due to main effect of sorghum population and groundnut population. Year by location showed that no significant difference due to panicle length. Cropping system in 2014 in Fadis showed that no significant effect on panicle length of sorghum; this might be due to environmental change from year to year. Similar trends was observed in Erer.

Sorghum yield kg ha⁻¹

The analysis of variance revealed that sorghum yield was significantly affected due to main effect of sorghum and groundnut population. And also significant difference was obtained in intercropping system. However highest sorghum grain yield was obtained in sole sorghum than intercropped sorghum. At both Fadis and Erer site sorghum grain yield significantly affected due to main effect of sorghum population and groundnut population.

Groundnut yields kg ha⁻¹

The analysis of variance revealed that sorghum grain yield was significantly affected due to main effect of sorghum population density and groundnut population density. cropping system significantly influence groundnut population the highest groundnut population was recorded in sole groundnut while the lowest yield was obtained in intercropped groundnut .this might be due to competition effect of crops for nutrients , sun light and moisture. Similar result was obtained in 2014 at Erer Location (site).

Land Equivalent ratio

Land equivalent ration was significantly affected due to main effect of sorghum population density and groundnut population density the highest LER was recorded due to cropping system the highest LER was recorded in intercropping system while the lowest was recorded in sole cropping system at all location.

The research result showed that, there were significance difference for both sorghum and ground nut yield per hectare in the years (2014) among treatments (Table 1). The sorghum sole yield in 2014 were (2974kg ha⁻¹sorghum and 2511kg ha⁻¹ groundnut) and 2015 (2501kg ha⁻¹ sorghum and 1017kg ha⁻¹

groundnut), respectively Even though the sole sorghum yield per hectare were relatively looks like high, the cumulative yield of intercropping yield were higher than the sole sorghum. Here not only grain yield but also in terms of soil fertility, economic monetary value, and other social and economic advantages intercropping is best practices in the case of eastern hararghe zones [26]. Because rain fall is erratic sometimes it is fully stopped at heading and flower stages. Why because there is no grain filling and sorghum is used for only fattening purpose rather than food consumption. This is the reason why eastern parties the country's relies on safety net. Highest yield ha⁻¹ (2865kg ha⁻¹ sorghum and 2729kg ha⁻¹ groundnut) and (2974kg ha⁻¹ sorghum and 2511kg ha⁻¹ groundnut) obtained at intra spacing of 30cmx20cm and 25cmx30cm, respectively under sorghum intercropping with ground nut and having more than 1 land equivalent ratio (1.31 and 1.27) (Table 2).

The research result showed that, there were significance difference for both sorghum and ground nut yield per hectare in the years (2014 and 2015) among treatments (Table 2). The sorghum sole yield in 2014 were (2974kg ha⁻¹ sorghum and 2511kg ha⁻¹ groundnut) and 2015 (2501kg ha⁻¹ sorghum and 1017kg ha⁻¹ groundnut), respectively. Even though the sole sorghum yield per hectare were relatively looks like high, the cumulative yield of intercropping yield were higher than the sole sorghum. Highest yield ha⁻¹ (2865kg ha⁻¹ sorghum and 2729kg ha⁻¹ groundnut) and (2974kg ha⁻¹ sorghum and 2511kg ha⁻¹ groundnut) obtained at intra spacing of 30cm x20cm and 25cm x30cm, respectively under sorghum intercropping with ground nut and having more than one land equivalent ratio (1.31 and 1.27) (Table 2). This implies that intercropping of sorghum and ground nut at intra spacing of 30cmx20cm and 25cm x30cm of sorghum with groundnut was advisable for intercropping [27]. This was because there was low competition beneath and above soil (low light, space, nutrient competition). And also the 1.31 and 1.27 land equivalent ratio showed that, we need additional 31% and 27% area of land to get same yield (2865kg ha⁻¹ sorghum and 2729kg ha⁻¹ groundnut) and (2974 kg ha⁻¹ sorghum and 2511kg ha⁻¹ groundnut) if sawn solely. At both location (Fadis and Erer) the data obtained were similar. This indicates that similar recommendation for the two locations.

Recommendation and Conclusion

The result over time (2014 and 2015) at Fadis and Erer showed that the highest sorghum and groundnut yield per hectare were obtained/harvested from the intra spacing of 25cmx20cm and 30cmx20cm intercropping sorghum with ground nut system with more than one land equivalent ratio. Therefore, the intra spacing of the main crop (sorghum) 25cm and 30cm and for the subsidiary crop (groundnut) 20cm was recommended for further production in the study areas of eastern Harerghe zone.

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DOI: [10.19080/ARTOAJ.2017.09.555763](https://doi.org/10.19080/ARTOAJ.2017.09.555763)

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