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EFFECT OF FERMENTED MANURES ON INTERCROPPED SUDAN GRASS (*SORGHUM SUDANESE* L.) AND CLITORIA (*CLITORIA TERNATE*) GROWN IN AN ARID SALINE ENVIRONMENT

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ABSTRACT

A field experiment was conducted at Hada Al-Sham Research Station of King Abdulaziz University over two successive seasons (2015/17) to evaluate the effect of a cereal (Sudan grass) intercropped with a leguminous (Clitoria) forage under saline arid environment. The treatments, besides intercropping, included fermented poultry and cow manures applied separately and in combination. A split plot design with three replicates was used. Intercropping treatments were randomly assigned to main plots whereas the manure treatments were assigned to sub- plots. Results showed significant differences for both fermented poultry and cow manures when combined together compared to other treatments for both growth and yield parameters. Moreover, intercropping of Clitoria with Sudan grass significantly increased both fresh and dry forage yields compared to sole crop during both seasons. The increments in dry forage resulting from combined poultry and cow manures ranged from 53.7 to 118% in the first season and from 146 to 514% in the second season. On the other hand, the increments in dry forage resulting from intercropping ranged from 82.4 to 203% in the first season and from 58.7 to 237% in the second season.
It can be concluded that fermented organic poultry and cow manures with intercropping of grasses and legumes can boost forage productivity under arid saline environment.

Keywords: Arid saline soils, Forage productivity, Grass-legume mixture, Organic manures.

INTRODUCTION

Arid lands are characterized with fragile ecosystems, low land productivity, limited good quality irrigation water and non-sustainable farming systems. The Kingdom of Saudi Arabia entirely lies within arid land with an annual rainfall ranging from 00 to 100 mm/annum. This limited rainfall coupled with high evaporation rates prevailing in the cultivable pockets in valleys of the western region, which mostly depends on saline irrigation, become more saline. According to Ventorino *et al*. (2012], the saline and harsh climatic condition hinder survival of *Rhizobium spp*., therefore, leguminous crops like Clitoria cannot form effective nodules to assist in nitrogen provision to the crop unless this situation reversed via soil amendment.

Organic farming has become one of the fastest growing segments of agriculture throughout the world. In conventional agriculture system use of chemicals has worried people about food quality, sustainability and other environmental consequences while organic agriculture assures high-quality food, sustainability and protect the environment (Sabrina *et al*., 2013). Saudi Arabia has low soil organic matter. It is well known that enrichment of organic matter reduce salinity effects and increases moisture conservation and as result stimulates crop growth and quality (Zirbin and Aragues, 2011). The use of organic fertilizers, particularly poultry and cow manures, are known to benefit soils under such adverse environment through improving soil physical and chemical properties, thereby enhancing crop productivity (Abusuwar and El Zilal, 2010). Several researchers pointed out that organic manure help in conserving cropping systems through recycling of nutrients (Domingues *et al*, 2014; Ze Ping *et al*., 2014). Moreover, Khan *et al*. (2008) reported that addition of organic manures with crop residues led to an increase in available phosphorus in soil. On the other hand, the use of inorganic fertilizers, particularly under saline condition, has not been helpful. It is often associated with reduced crop yield, cause soil acidity and nutrient imbalances (Abusuwar and Bakhshawain, 2011). Intercropping, which is defined as the growing of two or more crop species simultaneously in the same field during a growing season (Ofori and Stern, 1987), is important for the development of sustainable food production systems, particularly in cropping systems with limited external inputs (Adesogan *et al*., 2002). This may be due to some of the potential benefits of intercropping systems such as high productivity and profitability (Yildirin and Guvence, 2005), improvement of soil fertility through nitrogen fixation and excretion from the component legume (Howieson *et al*,. 2008), efficient use of resources , reducing damage caused by pests, diseases and weeds

(Banik *et al*., 2006), and improvement of forage quality through the complementary effects of two or more crops grown on the same piece of land (Hauggaard-Nelson *et al*., 2001; Bingol *et al*., 2007).

Sudan grass is one of the cereal forages with high yielding ability that gives up to four cuts during the growing season. Forage grasses benefit from the addition of legumes in the intercropping and the productivity may be equal to nitrogen fertilization (Ross *et al*., 2004; Dwivedi and Kumar, 1999). In drought stress experiment Eneji *et al*. (2008) found that Sudan grass, compared with the other three forage plants, was the least affected by deficit irrigation, possibly because of improved root mass and its natural drought tolerance. Jianwei *et al*. (2004) obtained five cuttings from Sudan grass in which the third harvest produced the greatest response as phosphorus fertilization increased yield by 28%.

In Africa, legumes have been tested as components of grass-legume mixtures, used to reinforce native pastures, established as fodder-banks, planted as intercrops and in leys, and in some cases, sown under trees in plantations (Thomas and Sumberg, 1995). The seeds are used in human food in many countries and the seed flour contained 30% protein on a dry weight basis (Venkatachalam and Sathe, 2007).

The objective of this research was to evaluate fermented organic cow and poultry manures as soil conditioners besides supplementing nutrients to intercropped cereal (Sudan grass) and leguminous (Clitoria) forages in saline environment.

MATERIALS AND METHODS

To evaluate the effect of intercropping of a cereal (Sudan grass) inter cropped with a leguminous (Clitoria) forage under saline arid environment, an experiment was conducted at Hada Al-Sham Research Station of King Abdul Aziz University over two successive seasons (2015/17). The treatments, besides intercropping, included fermented poultry and cow manures. The treatments consisted of 1-Fermented cow manure applied at a rate of 5 tons/ha- denoted as CM, 2-Fermented poultry manure applied at a rate of 5 tons/ha-denoted as PM, 3-Fermented poultry and cow manure combined at a rate of 2.5 tons/ha of each –this is denoted as PMCM, 4-control-no fertilizers added, denoted as C.

Before commencing experiment, ten random soil samples from the experimental site were analyzed for the chemical properties of the soil using an auger to a depth of 30 cm. Chemical properties of soil are presented in Table 1a.

The poultry and cow manures were fermented before use to eliminate all weed seeds and pathogens present in the manure. Thereafter, it was incorporated into soil before planting according to treatment. At the end of fermentation period, both cow and poultry manures were chemically analyzed as shown in Table 1b. Meteorological data, on monthly basis, for temperature, relative humidity and rainfall is presented in Table 2.

The layout of the experiment was a split-plot design , where intercropping treatments (pure Clitoria, pure Sudan grass and a mixture of both Clitoria and Sudan grass) were randomly assigned to main plots and fermented manures (PM,CM, PMCM, in addition to control) were assigned to sub-plots. Three replicates were used in each season.

Bore hole water was the source of irrigation which was pumped via perforated plastic pipes to the experimental plots. Experimental plot size was 2X2 meters. Salinity of the irrigation water was 3500TDS (ppm). Irrigation was applied lightly every other day to avoid salt crust on soil surface. Weeding was carried out manually twice each season to get rid of unwanted weeds.

It should be mentioned that growth parameters were carried out for the cereal forage rather than the leguminous forage as the growth habit of the legume forage is different from that of the cereal forage which could make comparisons between the two forages, for growth parameters, of little use. Therefore, growth parameters were taken only for Sudan grass but yield parameters for both.

Growth parameters: The growth parameter of plant height, number of leaves per plant, leaf firing ratio, leaf stem ratio and total leaf area per plant were measured. This is in addition to forage productivity in terms of fresh and dry matters.

Measurement of plant height for Sudan grass were taken randomly for ten plants from the center of each treatment. Height was measured from ground surface to tip of plant (tip of flag leaf) at each harvest. The ten plants random selected for plant height were used for measuring other growth parameters including number of leaves per plant. At time of harvest all number of leaves, including dead or dried leaves, were counted and the average number of laves per plant was recorded.

Number of dead leaves per plant was counted for the same plants used for counting total number of leaves per plant to calculate leaf firing ratio for each treatment. Leaf firing ratio was calculated using the formula: Leaf firing ratio= number of dead laves per plant/ total number of leaves per plant. This parameter gives an indication on how long leaves remain green and healthy on plants before senescence, which is an important character in forage quality and quantity.

Leaf/stem ratio for the ten randomly selected plants was measured on dry weight basis by measuring weight of dry leaves over their dried stems.

Ten random plants at harvests were used for calculating total leaf area per plant. Measurements of the entire length of leaf blade and the maximum width were taken for each leaf of the ten random plants. Then leaf

area was calculated according to Kemp (1960) using the formula: Leaf area=KLW, where K is a constant in cereals equals to 0.75, L is maximum length of the blade and W is maximum width of the blade. From this total leaf area per plant was calculated by multiplying leaf area times the number of leaves per plant.

Forage productivity (tons\ha) The entire plot (2m2) was harvested and weighed to get forage fresh yield, whereas a sample was taken from each plot, oven dried to obtain dry yields. Both fresh and dry yields were transformed from kg/ha into tons/ha.

Experimental Design and data analysis: A split plot design was used and analysis of variance (ANOVA) was performed on data according to Steel *et al*. (1997). Means of treatments were separated according to the LSD method.

RESULTS

Organic matter, nitrogen, phosphorus and potassium contents of the experimental soil were relatively low in comparison to Na, Mg and Ca contents (Table 1a). The electric conductivity was 5.5. It is worth mentioning here that the irrigation water salinity was 5000ppm.

Chemical analysis of the fermented organic manures indicated that poultry manure contained about three folds nutrients compared to cow manure (Table 1b). It showed poultry manure was much richer in nutrients compared to cow manure. It contained three folds nutrients that was present in cow manure.

Meteorological data for the experimental period is presented in Table 2. It included minimum and maximum temperatures (C^o), minimum and maximum relative humidity (%) and total rainfall per month (mm). Maximum temperatures in the upper forties were recorded during the Summer season, whereas the lowest of 20 C^o or less are recorded during winter and autumn. Rainfall and relative humidity reached maximum during autumn.

Effect of treatments on growth parameters: Effect of main plot treatments on the cereal plant height (Table 3) showed that mixture of fermented cow manure and poultry manures resulted in taller plants compared to manures applied alone or the control and it was significant throughout the different cutting dates in both seasons except the second cut of the first season.

In the subplot treatments Sudan grass grew taller in the mixture compared to when grown as sole crop throughout the two seasons and the difference was significant.

The main plot treatments showed that the fermented mixture of manure resulted in more number of leaves per plant compared to other treatments and the difference was significant except for the first cut during the first season (Table 4).

In the sub-plot treatments Sudan grass grown in the mixture resulted in higher number of leaves compared to Sudan grass grown as sole crop. The difference was significant throughout the different cutting dates in both seasons.

The highest leaf firing ratio was always recorded for the control treatment, whereas the lowest leaf firing ratio was always recorded for the fermented mixture in both seasons and it was significantly different (Table 5).

In the sub-plot treatments higher leaf firing ratio was always recorded in the pure stand compared to the mixture and the difference was significant throughout the two seasons in all cuts.

Effect of treatments on leaf /stem ratio of Sudan grass is presented in Table 6.The combined fermented poultry and cow manures resulted in higher leaf stem ratio in both seasons and the difference was significant The least values for leaf stem ratio were always recorded for the control in all cut during both seasons.

For the subplot treatments, the cereal when grown as a mixture with the legume resulted in high leaf stem ratio and it was significant throughout the different cuts in both seasons.

Effect of treatments on total leaf area /plant is presented in Table 7. The combined poultry and cow manure treatment (PMCM) resulted in higher total leaf area per plant compared to other treatments all cuts throughout the two seasons and the difference was significant. Least total leaf area per plant was always recorded for the control treatment.

Similar to other growth parameters, total leaf area per plant was higher for the cereal grown in the mixture compared to the cereal grown as sole crop. The least total leaf area per plant was always recorded for Sudan grass grown as sole crop.

Weather conditions of relatively high rainfall during second year had positive effects on number of leaves per plant, leaf stem ratio and leaf area per plant.

Effect of treatments on forage production

Forage fresh yield (tons/ha): Effect of treatments on forage fresh yield (tons/ha) is presented in Table 8. Fermented poultry and cow manures when mixed in equal ratios resulted in higher forage fresh yield compared to other treatments throughout the experimental period in all cuts and the difference was significant. The minimum fresh forage was always recorded for the control treatments. The increments in forage fresh yields resulting from combined poultry and cow manure treatment, ranged from 82.3 to 86.5% in the first season and from 84.3 to 320% in the second season.

For the subplot treatments, the intercropping of the cereal and the legume (mixture) resulted in significantly higher fresh yield compared to other

treatments. The least fresh forage yield was always recorded for the legume grown as a pure stand. The increment in fresh forage resulting from intercropping ranged from 189 to 391% in the first season and from 80.5 to 108% in the second season.

Forage dry matter (tons/ha): The organic manures applied in all cuts in the two seasons (Table 9) significantly affected forage dry matter production. The fermented poultry and cow manures mixed together significantly increased dry matter production compared to other treatments. The least dry forage was produced in the control and the cow manure treatments. The increments in dry forage resulting from combined poultry and cow manures ranged from 53.7 to 118% in the first season and from 146 to 514% in the second season.

In the subplot treatments, the same trend observed for fresh forage production was repeated in dry matter production. Higher dry forage yield was produced for the intercropped treatment (mixture) followed by sole Sudan grass and the least dry forge forage was recorded for sole Clitoria and the difference was significant except for final cut in the second season. The increments in dry forage resulting from intercropping ranged from 82.4 to 203% in the first season and from 58.7237% in the second season.

Table 1a. Chemical properties of the experimental soil.

Ec	%pH	%OM	%N	%P	%K	%Ca	%Mg	%Na
5.5	7.72	0.045	0.020	0.045	0.035	0.283	0.269	0.35

Table 1b. Chemical analysis of poultry and cow manures.

	N (gkg^{-1})	P (gkg^{-1})	K(gkg^{-1})	C (gkg^{-1})	C/N
Poultry manure	16.35	3.90	23.95	255	16.1
Cow manure	7.58	1.02	12.80	87	13.1

Table 2. Meteorological data for the experimental period at Hada Al-Sham Experimental Research Station.

year	month	Temp.min. C	Temp.max C	RH min%	RH. Max%	RF. Total mm
2015	4	19.71	39.77	21.33	98.75	0.28
2015	5	23.17	43.08	12.91	99.00	-
2015	6	19.97	46.43	16.64	99.75	-
2015	7	22.62	43.41	15.11	76.00	-
2015	8	26.42	47.05	21.64	99.75	12.47
2015	9	24.33	44.96	13.41	97.40	2.42
2015	10	22.83	42.72	11.22	97.95	1.09
2015	11	18.00	36.96	23.67	99.80	14.10
2015	12	15.22	31.72	28.38	100	5.01
2016	1	10.88	30.40	32.32	100	4.01
2016	2	10.99	36.04	14.75	99.80	-
2016	3	15.55	40.04	12.39	99.8	-
2016	4	15.68	39.66	15.57	98.60	34.53
2016	5	22.21	44.91	11.44	99.30	9.40
2016	6	22.80	45.51	10.24	93.65	-
2016	7	23.42	42.47	14.88	85.35	-
2016	8	23.42	43.31	21.32	98.20	0.66
2016	9	22.68	43.25	13.55	99.70	9.95
2016	10	20.62	40.96	11.60	100	3.65
2016	11	18.04	36.71	13.83	100	0.20
2016	12	14.53	32.78	30.93	100	1.55
2017	1	13.23	33.40	28.24	99.90	0.15
2017	2	15.61	32.97	25.22	100	0.35
2017	3	25.01	33.41	34.56	92.60	-

Units:
Temperature in Celsius
Relative humidity (%)
Rainfall in mm

Table 3. Effect of treatments on Plant height (cm) of Sudan grass and its intercropping with Clitoria.

Season.	**First season**			**Second season**		
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	115.83 b	116.17	101.25 c	100.83c	133.50d	71.50c
CM	128.00ab	126.33	127.15 b	110.66b	145.83c	91.83bc
PM	133.16a	128.00	133.56 b	116.66b	153.66b	102.33b
PMCM	136.5a	154.67	153.15 a	1`28.33a	185.16a	150.00a
LSD	12.17	NS	13.17	6.96	1.80	24.81
Sub-plots						
Pure	119.66b	115.83b	113.72 b	103.75b	152.16b	88.33b
mix.	137..08a	146.75a	150.00 a	124.50a	156.91a	119.50a
LSD	15.40	15.80	16.25	4.92	1.27	17.54
CV	7.55	24.08	15.35	4.58	0.87	17.93

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 4. Effect of treatments on number of leaves/ plant of Sudan grass and its intercropping with Clitoria.

Season	**First**	**season**		**Second**	**season**	
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	8.3	6.00b	7.0 c	7.83b	7.83b	7.33c
CM	8.3	6.16ab	7.5 b	8.33b	8.00b	8.50bc
PM	8.3	6.66ab	7.4 b	8.33b	8.16b	9.16b
PMCM	8.5	7.16a	8.1 a	10.16a	10.16a	10.50a
LSD	NS	0.60	0.4	1.12	1.15	1.21
Sub-plots						
Pure	7.16b	5.75b	4.8 b	7.83b	7.75b	7.75b
mix.	9.58a	7.25a	6.2 a	9.75a	9.33a	10.00a
LSD	1.95	1.00	1.2	0.79	0.81	0.85
CV	13.57	11.75	12.75	9.57	10.13	10.28

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 5. Effect of treatments on Leaf firing ratio of Sudan grass and its intercropping with Clitoria.

Season	**First**		**Season**	**Second**		**season**
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	0.37a	0.42a	0.41 a	0.37a	0.39a	0.43a
CM	0.28b	0.31ab	0.33 b	0.29b	0.23b	0.22b
PM	0.27b	0.26b	0.30 b	0.20c	0.19b	0.19bc
PMCM	0.21d	0.20b	0.16 c	0.20c	0.14b	0.12c
LSD	0.05	0.13	0.05	0.06	0.08	0.07
Sub-plots						

Pure	0.28a	0.28a	0.27 a	0.33a	0.29a	0.29a
mix.	0.21b	0.16b	0.18 b	0.20b	0.19b	0.19b
LSD	0.04	0.09	0.08	0.04	0.06	0.05
CV	CV	10.96	26.07	0.18	18.01	27.21

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 6. Effect of treatments on Leaf: stem ratio of Sudan grass and its intercropping with Clitoria.

Season.	**First**		**season**	**Second**		**season**
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	0.21b	0.16b	0.15 d	0.30 b	0.29 c	0.16 c
CM	0.24ab	0.20ab	0.21 c	0.32b	0.33 b	0.21 b
PM	0.26a	0.23ab	0.25 b	0.33b	0.39 a	0.28 a
PMCM	0.26a	0.29a	0.30 a	0.38a	0.42 a	0.31 a
LSD	0.04	0.08	0.03	0.04	0.03	0.04
Sub-plots						
Pure	0.21b	0.16b	0.17 b	0.32 b	0.31 b	0.22 b
mix.	0.28a	0.28a	0.24 a	0.36 a	0.38 a	0.30 a
LSD	0.04	0.09	0.06	0.03	0.05	0.06
CV	14.87	33.71	22.15	21.15	18.15	19.05

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 7. Effect of treatments on total Leaf area/ plant of Sudan grass and its intercropping with Clitoria.

Season.	**First**	**season**		**Second**	**season**	
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	523.33b	596.83c	560.33 d	384.7c	350.33c	290.00d
CM	565.5b	763.00b	695.20 c	461.0c	491.67c	482.67c
PM	638.83b	884.50b	840.12 b	915.8b	909.83b	874.17b
PMCM	812.00a	1033.33a	971.22 a	1152.7a	1140.83a	1110.00a
LSD	116.00	139.00	125.18	233.64	218.27	169.17
Sub-plots						
Pure	410.42b	591.25b	582.12 b	467.50b	484.50b	461.08b
mix.	860.42a	1047.58a	840.13 a	971.58a	961.83a	917.33a
LSD	250.00	270.12	22013	165.21	154.34	119.62
CV	19.09	11.76	15.22	24.38	22.66	16.43

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 8. Effect of treatments on Fresh weight (ton/ha) of Sudan grass and Clitoria alone and its intercropping.

Season.	**First**		**season**	**Second**		**season**
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	11.6c	6.1c	6.2 c	15.3c	11.0c	5.8b
CM	13.9c	8.9b	9.5 b	17.2bc	14.6c	12.4b
PM	17.2b	10.9b	10.8 a	21.1b	31.7b	16.3b
PMCM	21.0a	11.38a	11.3 a	28.2a	46.2a	33.4a
LSD	2.5	2.4	1.0	4.4	11.6	13.80
Sub-plots						
Pure Sudan grass	17.3b	10.3b	16.5 a	19.7b	21.5b	11.9a
Pure clit.	7.6c	3.3c	6.3 b	13.5bc	20.0b	21.1a
mixture	22.9a	16.2a	18.2 a	28.1a	36.1a	18.0a
LSD	4.5	4.9	4.5	3.8	10.0	12.0
CV	19.85	23.75	23.5	21.77	22.97	21.58

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

Table 9. Effect of treatments on dry weight (ton/ha) of Sudan grass and Clitoria alone and its intercropping.

Season.	**First**	**season**		**Second**	**season**	
Cut No.	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Date	7/5/2015	17/12/2015	4/3/2016	7/5/2016	17/12/2016	4/3/2017
Main plots						
Control	4.3b	4.3d	4.1 d	5.0b	3.3c	4.9b
CM	5.5b	6.7c	6.5 c	4.3b	6.7c	8.4b
PM	8.6a	8.6b	7.4 b	6.6ab	10.9b	13.3b
PMCM	9.4a	10.3a	8.5 a	10.6a	17.8a	30.1a
LSD	3.0	1.6	0.8	4.2	3.8	1.29
Sub-plots						
Pure Sudan grass	8.0b	7.3b	10.2 b	6.0b	8.4b	10.3a
Pure clit.	3.2c	11.0c	7.4 c	3.2b	8.0b	16.0a
Mixture	9.7a	13.9a	13.5 a	10.8a	12.7a	16.2a
LSD	1.5	4.5	2.1	3.6	3.3	11.1
CV	28.01	22.75	23.76	25.47	24.67	21.91

*Figures followed by same letter (s) within each column for plots or subplots are not significantly different at 0.05 level of probability using LSD test
Control= no manure applied either for mixture or sole crop
CM= fermented cattle manure at a rate of 5 tons/ha
PM= fermented poultry manure at a rate of 5 tons/ha
PMCM=fermented poultry and cow manures applied at a rate of 2.5 tons/ha of each
LSD= Least significant difference at 0.05 level of probability
CV= coefficient of variation

DISCUSSION

Application of both fermented cow manure and poultry manure resulted in significant increases of all growth parameters compared to other main plot treatments throughout the experimental period. The only exception was leaf-firing ratio where the control treatments was superior over treatments. This is expected as early senescence and death of leaves is associated with low nutrients and high salinity of the soil in the control treatment. Chemical analysis of the site soil indicated that it had low contents of organic matter, nitrogen, phosphorus and potassium and high contents of sodium.

Moreover, irrigation water salinity was 5000ppm. On the other hand, treated plots with organic manures (poultry and cow manures) improved soil physical properties (cow manure) and supplied soil with essential nutrients (poultry manure). The chemical analysis of the manure showed that poultry manure contained three folds of nutrients compared to cow manure. Zirbin and Aragues (2011) stated that organic matter reduces salinity effect, increases moisture conservation and stimulates crop growth and quality. Moreover, some researchers pointed out that organic manure help in conserving cropping systems through recycling of nutrients (Ze Ping *et al*, 2014).

Intercropping of Sudan grass with Clitoria (mixture) improved all growth parameters compared to sole crop in both seasons. Forage grasses benefit from the addition of legumes in the intercropping and the productivity may be equal to nitrogen fertilization as stated by Dwivedi and Kumar, 1999. In drought stress experiment Eneji *et al*. (2008) found that Sudan grass, compared with the other three forage plants, was the least affected by deficit irrigation, possibly because of improved root mass and its natural drought tolerance

Both fresh and dry forage productivity were significantly improved by mixing poultry and cow manures compared to other organic treatments. This could be explained on the basis that cow manure improves soil physical properties of soil, whereas poultry manure contribution is through supplying essential nutrients to the soil, thereby improving crop productivity. As shown for the positive effect of organic nutrients on growth parameters, it is expected to be reflected on forage productivity, as yield is the resultant of all growth parameters.

Intercropping of Clitoria with Sudan grass significantly improved both fresh and dry forage productivity throughout the experimental period. As noticed with the effect of intercropping on growth parameters, which were improved by intercropping, it would be reflected on forage productivity. Several researchers stated some of the potential benefits of intercropping systems such as high productivity (Yildirin and Guvence, 2005; Dominguez *et al*, 2014), improvement of soil fertility through nitrogen fixation and excretion from the component legume (Hauggaard-Nelson *et al*., 2001, Howieson *et al*. 2008),

It was noticed that forage productivity, for both fresh and dry matter, was higher in the second season compared to the first season regardless of the treatment used. This could be related to the meteorological data of rainfall, temperature and relative humidity collected during the study period. Although average rainfall in such areas rarely exceeded 100 mm per annum, it was noticed that most of this rain (about 40%) occurred during April and May of 2016, which coincided with second season. High temperatures and evaporation rates during hot summer increase salt deposits on soil surface that hurt plant growth and reduce productivity, but this phenomenon is reduced by rainfall, which could leach deposited salts below rooting zone and hence mitigate its deleterious effect.

Based on the present investigation, it can be concluded that fermented organic poultry and cow manures with intercropping of grasses and legumes can boost forage productivity under arid saline environment.

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1