GROWTH PARAMETERS AND FORAGE YIELD OF TWO GRAIN SORGHUM (Sorghum bicolor L. Moench) VARIETIES UNDER DIFFERENT PLANTING DATES AND AGES OF HARVEST IN SHIKA

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ABSTRACT
To determine the influence of sorghum variety, planting dates and ages of harvest on growth parameters and forage yield of grain sorghum (Sorghum bicolor L. Moench) in Shika, Nigeria, an experiment was conducted in split plots in the National Animal Production Research Institute, Shika, Nigeria. The experimental treatments comprised of two sorghum varieties (SAMSORG-16 as V1 and SAMSORG-17 as V2), three planting dates (15th June, 30th June and 14th July as P1, P2 and P3) and three ages of harvest (6, 10 and 14 weeks after sowing as C1, C2 and C3), respectively. Results showed that plant height of sorghum bicolor significantly (P<0.05) differed between variety with higher values in Samsorg-16. Plant height, number of leaves and leaf area index (LAI) decreased (P<0.05) from 15th June to 14th July planting date. However, there was a significant increasing trend (P<0.05) in these parameters as ages of harvest advanced from 6 to 14 week after sowing (WAS). Significant (P<0.05) interaction effect between variety and planting date was observed for plant height. Similarly, significant (P<0.05) interaction effect was observed in the number of leaves and LAI. There was non-significant (P>0.05) effect of variety on fresh and dry forage yields. Fresh and dry forage yields declined from 54.73 and 10.49 t/ha to 30.72 and 6.11 t/ha from 15th June to 14th July planting dates, respectively. Whereas fresh and dry forage yields increased from 12.22 and 1.37 t/ha to 58.94 and 14.47 t/ha as ages of harvest increased from 6 to 14 WAS, respectively. Based on the results of this study, it can be concluded that livestock farmers in Northwest Nigeria could grow Samsorg-16 and Samsorg-17 for forage which could be harvested at 14 WAS for better forage yield.

Keywords: Age of harvest, sorghum, variety and planting date.

INTRODUCTION
Increased population growth and inability of rangelands to support livestock needs lead agronomists to pay more attention to cultivation of forage plants (Jooorabi et al., 2015). Sorghum has good characteristics such as high yield and tillering potential, rapid growth and high nutrient contents. It has a number of morphological and physiological characteristics that contribute to its adaptation which make it most considered in arid and semi-arid regions of the world (Ayub et al., 2007; Munza et al. 2018).

Genotype or variety plays an important role in determining yield of sorghum. For example, late maturing cultivars are likely to have higher biomass yield than early maturing ones, since the stem components and number of leaves are higher (Taylor et al., 1974; Munza, 2017). Sorghum is used for both grain and forage; while some varieties are grown solely for grain, others have been developed for forage production, and some varieties are dual-purpose (Harada et al., 2000). SAMSORG-16 and SAMSORG-17 are grain sorghum varieties with released names SSV2 (FBL) and KSV3 (SK.5912), respectively (Aba et al., 2004). They are potential forage crops that are adapted to Northern and Southern Guinea Savanna zones of Nigeria. SAMSORG-16 has a maturity period of 165 – 175 days for grain whose seed colour is white with a grain potential yield of 2.5 – 3.5 ton/ha. SAMSORG-17 popularly known as Short Kaura has a maturity period of 165-175 days for grains whose seed colour is yellow with a potential grain yield of 2.5-3.5 ton/ha (Aba et al., 2004). The agronomic and forage potential of these sorghum varieties is encouraging. For example, Munza et al. (2018) reported a plant height of 77.89 cm, number of leaves of 8.03, leaf area index of 2.06 and fresh and dry forage yields of 38.06 and 9.06 t/ha, respectively for SAMSORG-16 at Shika, Nigeria.

Planting date influences seed germination in sorghum through environmental temperature and soil available (Vanderlip, 1993), vegetative and reproductive success (Prasad et al., 2008), as well as yield and yield components (Diawara, 2012). Jones and Johnson (1991) reported that effect of stress due to
environmental factors on final yield of sorghum may depend upon genotype and growth stages in which it occurs. Deciding on early or late planting depends on a farmer’s ability to deal with the risk of poor crop establishment with early planting or the effect of water or heat stress at reproductive stages with late planting. Heiniger et al. (1997) stated that early planting may result in an unfavorable soil environment, which may affect emergence rate, and results on poor stand establishment and possibly replanting. Delaying the planting date until soil conditions are nearer the optimum for early plant growth and development may be a management strategy useful in overcoming these problems (Diawara, 2012).

Age of harvest plays an important role in yield determination. Generally, total dry matter increases as harvesting is delayed, especially when harvesting occurs between vegetative and booting stage (66% DM) (Munza, 2017). During early growth stages of a forage crop, leaves yields double those of stems but at later stages the situation changes and stems yields are twice those of leaves (Nelson and Moser, 1994; Munza, 2017). In a study to determine the effect of plant spacing and stage of harvest on forage yield and quality of grain sorghum, Munza et al. (2018) found that plant height, number of leaves and leaf area index increased significantly as the stage of harvest advanced from 6 to 12 weeks after sowing (WAS). Large variability exists in sorghum growth and development in response to planting date and hybrid selection (Diawara, 2012).

Table 1: Meteorological distribution of the experimental location in 2018

|                | Max Air Temp (°C) | Min Air Temp (°C) | Relative Humidity (%) | Rainfall (mm) | Sunshine (Hours) |
|----------------|------------------|------------------|-----------------------|---------------|------------------|
| January        | 39.48            | 15.35            | 15.7                  | 0             | 7.89             |
| February       | 34.48            | 18               | 12.74                 | 0             | 7.43             |
| March          | 34.71            | 24.06            | 28.19                 | 25.3          | 6.48             |
| April          | 39.47            | 25.8             | 40.67                 | 2.2           | 7.8              |
| May            | 35.16            | 24.16            | 56.1                  | 81.3          | 7.83             |
| June           | 31.4             | 23.2             | 70.47                 | 133.3         | 7.12             |
| July           | 30.84            | 22.94            | 75.94                 | 218.4         | 5.9              |
| August         | 30.55            | 21.9             | 78.12                 | 268.8         | 6.68             |
| September      | 31.62            | 25.45            | 71.19                 | 229.2         | 6.51             |
| October        | 33.23            | 18.23            | 55.68                 | 61.6          | 6.55             |
| November       | 33.83            | 12.8             | 21.93                 | 0             | 5.39             |
| December       | 32.1             | 14.58            | 19.39                 | 0             | 8.86             |

Source: IAR, 2019

The soil consists of 60% sand, 14% clay and 26% silt giving rise to sandy loam while the organic carbon was 0.94%. The pH value recorded was 5.20 and 4.20 for H₂O and 0.01M CaCl₂, respectively which shows that the soil is slightly acidic in nature. Typically with tropical soils, the soil of the experimental site is low in both total nitrogen (0.140%) and available phosphorus (21.53 ppm). The exchangeable cations present in the soil samples are Ca²⁺, Mg²⁺, K⁺ and Na⁺ which are needed for growth and development in plants. Also the soil has cation exchange capacity, exchangeable acidity and electrical conductivity of 8.20, 0.80 cmol/kg and 0.030 dsm, respectively.

The objective of this research was to determine the influence of sorghum variety, planting dates and ages of harvest on growth parameters and forage yield of grain sorghum in Shika, Nigeria.

MATERIALS AND METHODS

Experimental site and location

The experiment was conducted during the 2018 raining season at the Experimental Farm of the Feeds and Nutrition Research Programme, National Animal Production Research Institute (NAPRI), Shika. The farm is located on Latitude 11° 12’ N, Longitude 07° 33’ E at an altitude of 660 m above sea level, along Zaria-Funtua Road in the Northern Guinea Savannah zone of Nigeria (Ovimaps, 2017). The climate is characterized by a defined wet and dry season. Wet season starts from April to early May and ends in late September to early October while the dry season lasts from October to April. The total annual rainfall ranges from 748.6 – 1156.7 mm with a long-term average of 1058.60 mm. Maximum air temperature of 35.16°C are recorded in May and minimum air temperature of 11.5°C recorded in December/January and relative humidity of approximately 70% during the rainy season (IAR, 2017). Weather observations taken at IAR meteorological station is shown in Table 1.
Experimental design, treatments and source of experimental materials
A land area measuring 35m x 18m (0.063ha) was used for the trial. The land was ploughed and harrowed with tractor drawn implements and ridged with two work bulls to provide a clean seedbed and to enhance early seed germination. The experiment was laid in a split plot design with a factorial arrangement (2 x 3 x 3) consisting of two sorghum varieties (SAMSORG-16 as V1 and SAMSORG-17 as V2), three planting dates (15th June, 30th June and 14th July as P1, P2 and P3) and three ages of harvest (6, 10 and 14 weeks after sowing as C1, C2 and C3), respectively.

Grain sorghum seeds were obtained from the Institute for Agricultural Research (IAR), Zaria. SAMSORG-16 and SAMSORG-17 varieties were preferred to other varieties, because of their adaptability to the environment of the study and forage yield potentials (Aba et al., 2004; Munza, 2017). Five (5) seeds were planted on ridges at 2 cm depth at plant spacing of 15 x 85 cm using the planting dates and later thinned to two (2) plants/stand after twelve (12) days so as to have a uniform plant population of (13,333 stands/ha). A uniform dose of 120 kg/ha NPK (20:10:10) was applied to grain sorghum seedlings at 2 and 5 weeks after sowing as first and second doses, respectively. Weeding was done manually as the need arises.

Data collection on plant growth parameters and yield components
Seedling emergence was monitored at 4 days after sowing. Germination count was done at 12 days after sowing. Data on yield and crop phenology was measured at 6, 10 and 14 weeks after sowing (WAS) on primary growth. Five (5) plants were randomly sampled per plot and tagged for measurements of various agronomic parameters using the standard procedure as reported by Tarawali et al. (1995).

Plant height:
The plant height of grain sorghum was determined by measuring from the base of the plant to where the last leaf on the stem emerges with the aid of a 200cm ruler on 5 randomly selected stands per plot.

Number of leaves per plant:
The number of leaves on the 5 randomly selected and tagged plants per plot was counted and the mean number of leaves per plant was determined from each plot at 6, 10 and 14 WAS.

Leaf area index (LAI):
Leaf area was measured using the method described by Stickler et al. (1961), i.e LA = length of the lamina x the largest width x a factor (0.747). The means were later recorded. The leaf area index was determined from the ratio of leaf per plant to the unit area of land covered by each plant (Watson, 1952).

\[
\text{LAI} = \frac{\text{Leaf Area per Plant (cm)}}{\text{Area of Ground per Plant (cm)}}
\]

Forage yield:
This was determined at four (4) weeks interval directly by harvesting the fresh forage within each sub-plot in a 1m² quadrant at 15cm above the ground using a hand sickle. The total fresh forage and sub samples (150-200g) were weighed in the field using a sensitive weighing scale and sub-samples were oven dried at 65°C for 48 hours and reweighed to estimate dry matter yield.

Dry matter production was calculated as: (Total FW x (DWss/FWss)) x 10 = Dry matter kg/ha. (Tarawali et al., 1995) where:

\[
\text{Total FW} = \text{Total fresh weight from 1 m}^2 \text{in (g)}
\]

\[
\text{DWss} = \text{Dry weight of the sub-sample in (g)}
\]

\[
\text{FWss} = \text{Fresh weight of the sub-sample in (g)}
\]

Statistical analysis and model
Data on growth parameters and forage yield were analyzed using Repeated Measures ANOVA of SAS (2005). Significant treatment means were compared using Duncan’s Multiple Range Test (Duncan, 1955).

\[
Y_{ijk} = \mu + A_i + B_j + C_k + (A*B)_{ij} + (B*C)_{jk} + (A*C)_{ik} + (A*B*C)_{ijk} + E_{ijk}
\]

Where:

\[Y_{ijk} = \text{is the record of observations for dependent variables}
\]

\[\mu = \text{is the population mean}
\]

\[A_i = \text{effect of sorghum variety (i = 1 and 10)}
\]

\[B_j = \text{effect of planting dates (j = 15th June, 30th June and 14th July)}
\]

\[C_k = \text{effect of ages of harvest (k = 6, 10 and 14 WAS)}
\]

\[(A*B)_{ij} = \text{effect of variety and planting date;}
\]

\[(B*C)_{jk} = \text{effect of planting date and age of harvest;}
\]

\[(A*C)_{ik} = \text{effect of variety and age of harvest;}
\]

\[(A*B*C)_{ijk} = \text{effect of variety, planting date and age of harvest;}
\]

\[E_{ijk} = \text{random error assumed to be normally and independently distributed.}
\]

RESULTS AND DISCUSSION
Growth parameters of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions
Variety had no effect (P>0.05) on number of leaves and leaf area index (LAI) (Table 2). Plant height was significantly (P<0.05) affected by variety and V1 (Samsorg-16) had significantly higher plant height than V2 (Samsorg-17) which could be attributed to tall nature of the variety. There was significant (P<0.05) planting dates effect on plant height, number of leaves and LAI (Table 2). Plant height was higher at P1 (15th June) which was at par with P2 (30th June) and lower at P3 (14th July). The first planting date (P1) led to significantly higher number of leaves and LAI than P2 and P3 which were statistically similar. Early planting might have had more environmental resources for growth hence more leaves per plant and wider LAI. Yu and Tuinstra (2001) stated that early planting of grain sorghum allows for a longer growing season and for more efficient use of environmental resources (e.g rainfall). This agrees with Clark (1997) who reported that
favorable temperature and rainfall during May and early June contribute to excessive vegetative growth. Radiation interception and photosynthesis are of major importance in yield determination due to their role in dry matter production (Diawara, 2012). Ages of harvest had significant (P<0.05) effect on plant height, number of leaves and LAI (Table 2). Plant height, number of leaves and LAI increased in advance in age of harvest. Increase in plant height, number of leaves and LAI as harvesting age was delayed from C1 (6 WAS) to C3 (14 WAS) might be due to the increase in physiological activities of the plant since sorghum is a C4 plant which utilizes sunlight energy, nutrients and water resources differently compared to C3 plants such as rice. The increase in LAI is expected due to increased photosynthetic ability and increased light interception as a result of leaf area and position etc. This agrees with the findings of Ishiaku (2016) and Munza et al. (2018) who reported increase in plant height, number of leaves and LAI as the stage of harvest advanced.

Table 2: Growth parameters of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions

| Treatment      | Plant Height (cm) | Number of Leaves (no.) | LAI   |
|----------------|-------------------|------------------------|-------|
| Variety        |                   |                        |       |
| V1             | 239.19<sup>a</sup> | 13.06                  | 6.12  |
| V2             | 156.14<sup>b</sup> | 13.09                  | 6.03  |
| SEM            | 11.69             | 0.48                   | 0.56  |
| P-value        | <0.001            | 0.910                  | 0.774 |
| Planting Date  |                   |                        |       |
| P1             | 211.12<sup>a</sup> | 13.73<sup>a</sup>      | 7.06<sup>a</sup> |
| P2             | 199.08<sup>a</sup> | 12.69<sup>b</sup>      | 5.47<sup>b</sup> |
| P3             | 182.79<sup>b</sup> | 12.80<sup>b</sup>      | 5.68<sup>b</sup> |
| SEM            | 7.79              | 0.32                   | 0.37  |
| P-value        | 0.004             | 0.004                  | 0.002 |
| Age of Harvest (WAS) |   |                        |       |
| C1             | 79.99<sup>c</sup>  | 9.63<sup>c</sup>       | 3.13<sup>c</sup> |
| C2             | 205.98<sup>b</sup> | 12.26<sup>b</sup>      | 6.12<sup>b</sup> |
| C3             | 307.02<sup>a</sup> | 17.33<sup>a</sup>      | 8.97<sup>a</sup> |
| SEM            | 7.79              | 0.32                   | 0.37  |
| P-value        | <0.001            | <0.001                 | <0.001|
| Interactions   |                   |                        |       |
| V x P          | 0.019             | 0.070                  | 0.089 |
| V x C          | <0.001            | 0.688                  | 0.969 |
| P x C          | 0.248             | <0.001                 | 0.005 |
| V x P x C      | 0.288             | 0.568                  | 0.951 |

<sup>a,b</sup>Means with different superscripts within columns differed significantly at P<0.05, SEM = standard error of mean, LAI = leaf area index, WAS = weeks after sowing, V1 = SAMSORG-16, V2 = SAMSORG-17, P1 = 15<sup>th</sup> June, P2 = 30<sup>th</sup> June, P3 = 14<sup>th</sup> July, C1 = 6 WAS, C2 = 10 WAS, C3 = 14 WAS

Variety and planting date interaction on plant height (cm) of grain sorghum

Significant interactions between variety and planting dates were observed on plant height (Table 3). Variety one (V1, Samsorg-16) planted on 15<sup>th</sup> June (P1) had significantly higher plant height which was at par with V1P2 (Samsorg-16, 30<sup>th</sup> June) and V1P3 (Samsorg-16, 14<sup>th</sup> July) followed by V2P1 (Samsorg-17, 15<sup>th</sup> June) and V2P2 (Samsorg-17, 30<sup>th</sup> June) which are similar while lower plant height was obtained in V2P3 (Samsorg-17, 14<sup>th</sup> July). The significant interaction effect of variety and planting dates observed in this study could be attributed to the positive correlation existing between variety and planting. It was revealed by Diawara (2012) that it is not just getting the right variety but the appropriate date of planting the variety. This agrees with Caravetta et al. (1990) who reported that growth components in sorghum were affected by genotype and environmental conditions. It also concurs with Diawara (2012) who reported significant variety and planting date interaction in grain yield and its components.

Table 3: Variety and planting date interaction on plant height (cm) of grain sorghum

| Planting Date | Variety | V1     | V2     |
|---------------|---------|--------|--------|
| P1            |         | 241.62<sup>a</sup> | 180.62<sup>b</sup> |
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\[ P_2 \begin{array}{c} 239.57^a \\ 236.37^a \end{array} \quad 158.58^b \]
\[ P_3 \begin{array}{c} 239.57^a \\ 236.37^a \end{array} \quad 129.21^c \]

\[ ^{a,b,c} \text{Means with different superscripts within a column or row differed significantly at (P<0.05), } V_1 = \text{SAMSORG-16, } V_2 = \text{SAMSORG-17, } P_1 = 15^{th} \text{ June, } P_2 = 30^{th} \text{ June, } P_3 = 14^{th} \text{ July} \]

Variety and age of harvest interaction on plant height (cm) of grain sorghum

Significant interactions between variety and ages of harvest were observed on plant height (Table 4). Variety one (V1, Samsorg-16) harvested at 14 WAS (C3) had significantly higher plant height than all other treatment combinations. This could be attributed to the positive correlation existing between plant height and age of harvest i.e. the more harvest age is delayed the more the plant height and the varietal difference. This agrees with Munza et al. (2018) who reported higher plant height for Samsorg-16 at 12 WAS in Nigeria.

Table 4: Variety and age of harvest interaction on plant height (cm) of grain sorghum

| Age of Harvest | Variety | V1   | V2   |
|----------------|---------|------|------|
|                | C1      | 86.97^a | 73.01^a |
|                | C2      | 241.18^b | 170.78^c |
|                | C3      | 389.42^a | 224.62^b |

\[ ^{a,b,c} \text{Means with different superscripts within a column or row differed significantly at (P<0.05), } V_1 = \text{SAMSORG-16, } V_2 = \text{SAMSORG-17, } C_1 = 6 \text{ WAS, } C_2 = 10 \text{ WAS, } C_3 = 14 \text{ WAS, WAS = weeks after sowing} \]

Planting dates and ages of harvest interactions on number of leaves and LAI of grain sorghum

Significant interactions between planting dates and ages of harvest were observed on number of leaves and LAI (Table 5). Higher number of leaves and LAI were obtained at 15th June planting date and 14 WAS age of harvest (P1C3) than all other treatment combinations. Sorghum yield response to time of planting and soil water storage were associated with difference in leaf area development (Muchow et al., 1994). This might be due to enough time for the treatment combination to utilize the available environmental resources. The number of leaves and leaf dimensions are functions of variety, growth stage but also depend on the growing conditions, planting date inclusive (Diawara, 2012).

Table 5: Planting date and age of harvest interaction on number of leaves and LAI of grain sorghum

| Planting Date | Age of Harvest | C1   | C2   | C3   | C1   | C2   | C3   |
|---------------|----------------|------|------|------|------|------|------|
| P1            | 10.30^a         | 11.50^a | 19.40^a | 4.23^d | 6.12^a | 10.84^a |
| P2            | 9.80^a          | 11.90^a | 16.37^b | 3.06^bc | 5.72^a | 7.63^bc |
| P3            | 8.80^a          | 13.75^d | 16.23^b | 2.11^c | 6.52^d | 8.43^d |

\[ ^{a,b,c} \text{Means with different superscripts within a column or row differed significantly at (P<0.05), LAI = leaf area index, P1 = 15^{th} \text{ June, } P2 = 30^{th} \text{ June, } P3 = 14^{th} \text{ July, } C_1 = 6 \text{ WAS, } C_2 = 10 \text{ WAS, } C_3 = 14 \text{ WAS, WAS = weeks after sowing} \]

Forage yield of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions

Variety had no significant (P>0.05) effect on fresh and dry forage yields (Table 6). The non-significant effect of variety on forage yield observed in this study could be attributed to the robust nature of V2 (Samsorg-17) which complements the tall nature of V1 (Samsorg-16).

Fresh and dry forage yields were significantly (P<0.05) affected by planting dates (Table 6). Fresh forage yield was significantly higher at P1 (15th June) than P2 (30th June) which was at par with P3 (14th July). Dry forage yield was higher at P1 (15th June) which was similar with P2 (30th June). This could be due to varietal, environmental or experimental conditions during the study. This agrees with Diawara (2012) who reported reduction in yield and yield components with delayed planting. Planting date affects not only the time from planting to flowering but time from flowering to physiological maturity of grain sorghum (Clark, 1997). Pauli et al. (1964) found that the total time from planting to physiological maturity was significantly decreased as planting time was delayed from early May to early June.

It was observed that age of harvest significantly (P<0.05) affected fresh and dry forage yields (Table 6). Fresh forage yield was higher at C3 (14 WAS) and similar with C2 (10 WAS) while dry forage yield was higher at C3 than C2 and C1 (6 WAS). This might be attributed to enough time for utilization of the available resources required for dry matter production. Radiation interception and photosynthesis are of major importance in yield determination due to their role in dry matter production. Sorghum yield response to location,
time of planting and soil water storage were associated with difference in leaf area development (Muchow et al., 1994). There was non-significant (P>0.05) interaction effect of variety, planting dates and ages of harvest for both fresh and dry forage yields.

### Table 6: Forage yield of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions

| Treatment          | Fresh Forage Yield (t/ha) | Dry Forage Yield (t/ha) |
|--------------------|---------------------------|-------------------------|
| Variety            |                           |                         |
| V_1                | 44.87                     | 9.13                    |
| V_2                | 38.62                     | 7.66                    |
| SEM                | 7.45                      | 1.88                    |
| P-value            | 0.132                     | 0.157                   |
| Planting Date      |                           |                         |
| P_1                | 54.73^a                   | 10.49^a                 |
| P_2                | 39.78^b                   | 8.59^a                  |
| P_3                | 30.72^b                   | 6.11^b                  |
| SEM                | 4.97                      | 1.25                    |
| P-value            | 0.001                     | 0.005                   |
| Age of Harvest (WAS) |                         |                         |
| C_1                | 12.22^b                   | 1.37^c                  |
| C_2                | 54.06^a                   | 9.36^b                  |
| C_3                | 58.94^a                   | 14.47^a                 |
| SEM                | 4.97                      | 1.25                    |
| P-value            | <0.001                    | <0.001                  |
| Interactions       |                           |                         |
| V x P              | 0.818                     | 0.664                   |
| V x C              | 0.525                     | 0.411                   |
| P x C              | 0.136                     | 0.308                   |
| V x P x C          | 0.902                     | 0.965                   |

^a^b^c^ Means with different superscripts within columns differed significantly, SEM = standard error of mean, WAS = weeks after sowing, V_1 = SAMSORG-16, V_2 = SAMSORG-17, P_1 = 15^th^ June, P_2 = 30^th^ June, P_3 = 14^th^ July, C_1 = 6 WAS, C_2 = 10 WAS, C_3 = 14 WAS

### CONCLUSION

Results of this study showed that variety, planting dates and ages of harvest increased growth parameters and forage yield of grain sorghum at Shika, Nigeria. Although Samsorg-16 appeared to have higher growth parameters (plant height, number of leaves and LAI) but the forage yield was essentially the same with Samsorg-17. It can therefore be recommended that livestock farmers in Northwest Nigeria could grow any of the sorghum varieties (Samsorg-16 and Samsorg-17) for forage provided it could be harvested at 14 WAS for better biomass.

### Conflict of interest

The authors have nothing to disclose.

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