

**INFLUENCE OF AGRICULTURE ADVISORY SERVICES ON ADOPTION OF  
SORGHUM PRODUCTION PRACTICES AMONG SMALLHOLDER FARMERS  
IN THARAKA SOUTH SUB-COUNTY, KENYA**

## ABSTRACT

The development and dissemination of agricultural advisory services (AAS) amongst smallholder sorghum farmers (SHFs) has played a crucial role in sorghum yield improvement in Kenya. However, there is limited information on the influence of AAS on adoption of sorghum production practices amongst SHFs in Tharaka Nithi County particularly Tharaka South Sub-County. The purpose of the study was to generate information that would deepen the understanding of the influence of AAS in enhancing the adoption of sorghum production practices in Tharaka South Sub-County. A descriptive research design was used to describe the characteristics of the study sample. The study targeted 16,437 smallholder sorghum farmers with a sample size of 108 participants. Stratified proportionate random sampling technique was utilized to select farmers from three strata; Marimanti, Nkondi, and Chiakariga wards. A questionnaire was used for data collection. Piloting study was carried out in South Imenti Ward, Meru County which helped to check and advance the validity of research instrument. The reliability of the research instrument was estimated by computing Cronbach's alpha coefficients of the variables. The Cronbach's alpha values for the study were: adoption of sorghum production practices ( $\alpha = 0.771$ ), while that of AAS was 0.710. The SPSS (V.22) was utilized for computing both the inferential (independent samples *t*-test) and descriptive (percentage, median, frequency, mean and standard deviation) statistics. The study findings indicated that there was no significant difference in the access and adoption of sorghum production practices between farmers with access to AAS from those who did not ( $t(106) = 0.843$ ,  $p = 0.401$ ,  $d = 0.1684$  and  $t(106) = 0.203$ ,  $p = 0.839$ ,  $d = 0.041$ , at 95% confidence interval, respectively). It was concluded that AAS had no influence on the adoption of sorghum production practices amongst SHFs in Tharaka Sub-County. Therefore, the study recommends the government through the State and County departments of agriculture should support impactful agricultural advisory programs that target sorghum farmers to increase the productivity of the crop.

**Keywords:** Innovation adoption, sorghum production practices, agricultural advisory services, indigenous knowledge and Smallholder.

## INTRODUCTION

Sorghum (*Sorghum bicolor*) is the 5<sup>th</sup> most important cereal crop cultivated for human consumption globally exceeded only by rice, wheat, barley and maize (Sarmiso, 2015). The grain species appeared to have originated from Australia, Africa, Indian Ocean, Mesoamerica, and parts of the Pacific Ocean. It serves as a cash crop and also consumed domestically. The crop offers a number of uses ranging from human food, biofuel, animal feed, production of flour and alcoholic beverages (Kanana, 2019). Nutritionists classify

sorghum as an extremely healthy cereal which is rich in vital nutrients that are very important in the body. Owing to its invaluable nutritional ingredients and commercial value, very many countries across the world advocate production of the crop for poverty alleviation and general improvement of people living standards (Hamukwala et al., 2010). For Industrial purposes, sorghum grain is utilized for synthesizing of dextrose agar, wax, animal gluten feed, carbohydrates, syrup, alcohol, edible lipids. The grains can also be mixed with legumes to reduce micronutrient malnutrition (Omolo, 2013).

The global sorghum production in 2017 was projected at 60.46 million metric tonnes with the western countries being the leading in tonnage. FAOSTAT (2017) positioned USA as the world's highest grower of sorghum, with a yield totaling 11.5 million metric tons. India comes second largest in sorghum production of about 7.5 million metric tonnes per annum assuming the largest area of cultivation (Mundia et al., 2019). African continent as a whole produced an average yield of 20 million metric tonnes yearly of sorghum coming third globally (Samuel et al., 2020). Sorghum cultivation in Eastern and Central Africa covers an area close to 10 million hectares. The leading producer in Africa country is Nigeria and ranks third across the globe with 7.4 million metric tonnes annually, 34% closely followed by Sudan, 21% (Mitaru et al., 2012). Ethiopia, Tanzania, Uganda, Rwanda and Kenya recorded 1.4 million metric tonnes, 800,000 tonnes, 400,000 tonnes, 160,000 tonnes and 120,000 tonnes per year, respectively of sorghum yield among the top crème in Africa (Mitaru et al., 2012).

Over the years, sorghum production in Kenya has largely remained for subsistence. Nevertheless, this is changing slowly with the upcoming sorghum (brewing) malting industry. The sorghum production gap stood approximately at 70,000 tonnes due to uncontrolled decline in country's sorghum yield record from 189,000 tonnes in 2015 to 117,000 metric tonnes in the year 2016 (FAOSTAT, 2018). Consequently, the little harvested sorghum yield thus, causes majority of smallholder sorghum farmers purchasing poor quality inputs contributed by absence of credit accessibility (Kanana, 2015).

A number of key initiatives which include policy support and partnerships in research and development have been adopted to address the yield and income improvement (Olayide et al., 2020). The Kenya Agriculture and Livestock Research Organization (KALRO) and the Ministry of Agriculture, Livestock and Fisheries Development have since the year 2010 been boosting indigenous prestigious crops for improved yield and income (Handsouch & Wollni, 2016). The respective government ministry, have also supported sorghum production on a commercial scale through research on suitable crop production practice (Mwadalu & Mwangi, 2013). This support is part of the broader strategy in the transformation of agriculture to a modern, innovative, and commercially oriented from subsistence economic perspective.

For sorghum, a standard production variant, which represents the most prevalent way of producing this crop, and several production alternatives are herein shown as critical if production is a way to pursue (Hausmann et al., 2012). A sorghum production practice describes all the necessary work steps required to produce the crop, such as land preparation, proper planting practices, application of fertilizers and pesticides, weed control, management of postharvest residues and ratooning management practices (Bayala et al., 2012). Thus, the production practices in sorghum do not represent actual production practices that refer to a concrete, but rather typify average production practices that are valid under yearly deviant weather conditions and that can be used for ex ante assessment (Sattler et al., 2010).

Extension systems are essential in providing farmers with knowledge and information about sorghum production practices for improving yield and income (UNDP, 2013). Therefore, the public sector must provide the necessary public commodities such as research, advisory service, and infrastructure development to support private sector investment in sorghum enterprise (Ochieng, 2017). Among the factors influencing the adoption of sorghum production practices for improved yield and income include use of traditional farming methods (Muui et al., 2013). For instance, smallholder sorghum producers prepare their land using oxen or human labor (Chepng'etich et al., 2014). A study in Imenti North, Meru County showed that access to advisory services was seen as

an untouchable motivation and especially it supported farmers to improve their yield and income (Kanana, 2019). However, there is limited information relating to influence of AAS on adoption of sorghum production practices for improved yield and income in Tharaka South Sub-County. Therefore, this study is an attempt to determine the influence of AAS on adoption of sorghum production practices for improved yield and income in Tharaka South Sub-County.

### **General Objective of the Study**

The general objective of the study was to generate information which would boost the understanding of the influence of AAS on the adoption of sorghum production practices, that would result in improved sorghum yield and income.

## **2. RESEARCH METHODOLOGY**

### **2.1 The Location of Study**

The study was conducted in Tharaka South Sub-County in Tharaka Nithi County, Kenya involving smallholder sorghum farmers. The Sub-County is situated between latitudes 0°30'S and 0°10'N and angular dimensions (longitudes) 37°40'E and 38°20'E (RCMRD, 2016). It is associated with a bi-modal precipitation (rainfall patterns) varying from 200mm to 800mm per annum (TCIDP, 2019) with temperature ranges between 22°C – 36°C and in some cases, it increases to a maximum figure of even 40°C.

### **2.2 Target Population**

The research targeted a population of 16,437 smallholder sorghum farmers within three wards of Tharaka South Sub-County. The sampling distribution formula as proposed in Nassiuma (2000) was used to come up with the required sample size for the study.

$$n = \frac{[NC^2]}{[C^2 + (N - 1)e^2]}$$

Where:

$n$  = The Sample size,

$N$  = Target Population,

$C$  = Coefficient of variation,

$e$  = Standard error.

The sample was arrived by the assistance of coefficient of variation, ( $C$ ). Nassiuma, (2000) denoted that in many surveys or experiments, a coefficient of variation in the range of ( $21\% \leq C \leq 30\%$ ) and a standard error, ( $e$ ) in the range ( $2\% \leq e \leq 5\%$ ) is usually acceptable. Therefore, a coefficient variation of 21% and a standard error of 2% was preferred for this study. The lower limit score for the coefficient of variation and standard error, ( $e$ ) is chosen so as to ascertain consistency in the sample and have insignificant degree of error. Therefore, the variables in the formula are as follows;  $N = 16437$  sorghum farmers in the Tharaka South Sub-County,  $C = 21\%$  and  $e = 0.02$  resulting to a sample size of 110 smallholder sorghum farmers.

$$n = \frac{16437 * (0.21)^2}{(0.21)^2 + (16437 - 1)(0.02)^2}$$

$$= 110$$

Therefore, this gave the sample size of 110 smallholder sorghum farmers for the study.

Stratified proportionate random sampling procedure was used as the smallholder sorghum farmers were spread within Tharaka South Sub-County, in the three selected wards. In each ward, four locations were randomly selected to give a total of 12 locations acting as areas of interest from which data were collected. The proportion of smallholder sorghum farmers in each Ward was presented as in Table 1.

Table 1: The Sample Size, ( $n$ ) in each of the Three Wards

Ward	Population	Sub-sample
Nkondi	3275	22
Marimanti	6499	43
Chiakariga	6663	45
Total	16437	110

### 2.3 Research Instruments

A semi-structured questionnaire was applied to gather data. A semi structured questionnaire was chosen because of ease of administration and scoring of the instrument and it also enabled the result to be readily analyzed. It is useful in that the response to items facilitates consistency across the respondents (Ogweno, 2016). In addition,

it allows participation by illiterate people and clarification of any ambiguity besides minimizing discrimination against the less articulate (Leung, 2001).

## 2.4 Data Analysis

The dependent variables were adoption of sorghum production practices. The independent variable was agricultural advisory services which was chosen by the researcher to study and make assessment for their possible impact(s) on single variable. The statistical package for the social science (SPSS) was used for data analysis. The software generated frequency tables and measures of central tendencies that was used to summarize the study variables. An independent sample *t*-test was adopted to process data collected. The assumptions of homogeneity of variance and normality were checked before performing the *t*-test. The homogeneity of variance for the study variables was checked by use of Levene's test while Kurtosis and skewness statistics was examined to determine normality (Garson, 2012).

## 3. RESULTS AND DISCUSSION

### 3.1 Access to Advisory Services

Access to AAS among smallholder sorghum farmers were evaluated using summated scores of five-point Likert type items; 1 signified inaccessibility and 5 meant very accessible. Table 2 indicates the frequency scores for the descriptive statistics of access to agricultural advisory services.

Table 2: Access to Agricultural Advisory Services<sup>d</sup>(*N* =108)

Variables	Median
Accessibility to information relating to improved sorghum varieties	3
Accessibility to information relating to weed control	3
Accessibility to information relating to diseases control	2
Accessibility to information relating to sorghum fertilizer application	3
Accessibility to information relating to insect pest management practices	2

The results showed that majority of farmers ( $M=3$ ) indicated that information relating to improved sorghum varieties was moderately accessible while some indicated the information is not available. The findings were in tandem with Schroeder et al. (2013) who

pointed out that farmers needed cheaply accessible excellent seeds which are locally agro-ecologically suitable, to facilitate production of the best possible crops. Similarly, a study by Ragasa et al. (2016) stated that smallholder enterprises can only blossom if the policy atmospheres are conducive with needed capacities to access improved seed innovation which are in place. The second group ( $M=3$ ) had the same opinion on the accessibility relating to weed control while only ( $M=2$ ) suggested that there was slightly accessible of information related to disease control. This study finding agrees with Khataza et al. (2018) who stated that accessibility of farmers to advisory service providers are likely an indicator to adoption of new technologies like disease control information.

The findings further indicated that farmers had moderate access to information relating to sorghum fertilizer application ( $M=3$ ). According to the result farmers' poor performance in indigenous crops in Tharaka South Sub-County have been mainly due to limited access to fertilizer and socio-economic constraints which are impetus to high yield outcomes in the study area. This agrees with Aune, (2017) who pointed out that high rate of return from agricultural productivity can only be realized if quality fertilizer and quality sorghum seeds are effectively utilized. A study by Niedertscheider (2011) indicated that the quantity of fertilizer used positively relates to the extent of improved grain varieties planted. Further, Chimoita et al. (2019) noted that to achieve optimal grain yields, smallholders' farmers should acquire and use fertilizer efficiently, which means in recommended amounts.

### **3.2 Sources of Agricultural Advisory Services**

Access to agricultural advisory services from different avenues amongst smallholder farmers appeared to be dissimilar in form, convenience in which the study sought to establish from the study respondents from the area in question. The respondents were asked to state the number of contacts made with advisory service providers. Table 3 shows the number of interactions with advisory service providers within Tharaka South Sub-County between the year 2018 and 2020.

Table 3: Response on Number of Contact with Advisory Service Providers ( $N = 108$ ).

Sources of advisory services	Yes		Farmer response No		Relative Percentage (%) Yes
	Freq.	Percent (%)	Freq.	Percent. (%)	
Mass media	77	70.6	32	29.4	24.8
Other farmers	72	66.1	36	33.0	23.2
County extension officers	56	51.4	53	48.6	18.1
KARLO	48	44.0	61	56.0	15.5
EABL	38	34.7	71	65.1	12.2
African harvest	8	7.3	101	92.7	2.6
Farmer groups	8	7.3	101	92.7	2.6
NGO	3	2.8	106	97.2	1.0

The results showed that farmers interacted with agricultural advisory services providers from different sources varying from mass media to inter-personal linkages. The study findings indicated that mass media (24.8%) was the most frequent platform of interaction between agricultural advisory service providers and farmers. Within Africa, the role of mass media in rural development has for long been recognized but their effectiveness and appropriateness vary because of differences in the socio-cultural context (Wanjala et al., 2016). This is in line with the findings of Sekabira et al. (2007) and FAO (2014) who noted that radios, TVs, videos, and telephones have traditionally been employed as communication tools to address extension-related challenges allied to access and use of agricultural innovation but their effectiveness to date is contested.

According to the study finding in the table above Adolwa et al. (2012) and Salifu and Salifu, (2015) various diffusion communication media channels have a particular competence to disseminate better innovations to the farmers. According to the study findings, Varble et al. (2016) noted that dissemination and application of improved and affordable communication platforms may drastically transform access to innovation in the village for accelerated crop productivity.

Farmers have a great deal of sharing innovation (23.2%) which they have accumulated over time through their local networks. This conforms to Susan and Wagoki (2014) who

states that accessibility to advisory services is perceived to have no tangible incentives, hence the difficulty to help farmers increase productivity. Similarly, Proenca (2016) pointed out that smallholder farmers enjoy a great deal of innovation accessibility from lead farmer through positive spillover. A third common advisory service provider to Tharaka South Sub-County smallholder farmers was the County extension officers, (18.1%). In line with this finding, Etyang et al. (2013) states that agricultural advisory service is a devolved role of the County governments therefore, establishment, maintenance, and strengthening of linkages with county governments will be key to success.

Further, the results showed that KARLO contributed a significant value in innovation dissemination (15.5%) to smallholder sorghum farmers. KARLO is a public parastatal spread throughout the country mandated to carry out various agricultural research and disseminate them to farmers. Provision of advisory services by EABL, (12.2%) was considerably significant among farmers. Other advisory providers included Africa harvest (2.6%), farmer groups (2.6%), and NGO (1%). According to Mousavi and Bossink (2020) the fiscal burdens of advisory service can be solved to some level if collaborations and complementarities with local Non-Governmental Organizations' training activities can be exploited. In addition to Anderson (2008) involvement of NGOs entails cost-sharing and allow expanded coverage among farmers. Contrary to the findings, in many resource poor countries, the existing NGOs do not have secure autonomous budgets, and thus dependence on such collaborations over a length of time may not be generally feasible (Dickovick, 2014).

Schroeder et al. (2013) established that there might be a likely correlation between access to AAS and farmers' adoption of current innovations. Further, there is a need for advisory service agents and other stakeholders to reflect on the commonly applied innovation dissemination outlets and target clientele with the adopted innovation on AASs in order to make adoption more significant and with the rapid consequence (Mlenga & Maseko, 2015).

### 3.3 Challenges Facing Smallholder Sorghum Farmers

Smallholder sorghum farmers were requested to indicate the challenges they face in their farming endeavors. The results of the farmers' response are presented in the Table 4.

Table 4: Opinions of Farmers on Challenges they Face in Sorghum Farming ( $N = 108$ )

Challenges facing sorghum farmers	Percentage (%)
Lack of farm inputs	58.3
Lack of farm machinery	69.5
Lack of finance	83.3
Use of uncertified seed	42.9
Poor storage facilities	73.6
Inadequate farm operations	41.7
Inadequate awareness of better sorghum production practices	81.9
Inadequate technical knowledge	55.2

The results revealed that farmers in Tharaka South Sub-County lack awareness of improved sorghum production practices (81.9%), lack of farm input (58.3%) and technological knowhow (55.2%) because the extension agents to farmer ratio is high. This result conforms with Kalimba and Culas, (2020) who highlights that many of the failures witnessed by smallholder farmers are as a result of extension agents lacking financial support to enable them reach many farmers and also carry out field days and demonstrations for particular agricultural packages.

Other problems encountered by smallholder sorghum farmers in Tharaka South Sub-County include the use of uncertified seed and late planting as cited by 42.9% and 41.7% of the respondents respectively (Table 4). Use of uncertified seeds and late planting could have been as a result of lack of finance which was also a problem cited by 83.3% of the respondents (Table 4). In relation to this study findings, Ali-Olubandwa et al. (2011) states that the most disturbing problem is the existence of a weak linkage between researchers, extension staffs and farmers as a result both the extension agents and farmers lack information on new and improved innovations.

### 3.4 Type of Extension Training Programs to Sorghum Farmers

The study intended to establish the type of extension training programs offered and their impacts to smallholder sorghum farmers within Tharaka South Sub-County. Majority of

the respondents had not been trained on sorghum production ( $n = 58, 53.7\%$ ) while those who had underwent training in the course of production season were ( $n = 50, 46.3\%$ ). Table 5 shows the distribution of smallholder sorghum farmers by training programmes.

Table 5: Sorghum Farmer Training Programme ( $N = 108$ )

Farmer Training Programme	Frequency		Percentage (%)	
	Yes	No	Yes	No
Pest and disease management	43	65	39.8	60.2
Planting practices	48	60	44.4	55.6
Fertiliser use	54	54	50.0	50.0
Post-harvest handling practices	32	76	29.6	70.6

The results showed that more than half ( $n=54, 50\%$ ) of the respondents had earlier participated in fertilizer use training and therefore an indication that the smallholder farmer had knowledge on the proper use of the fertilizer. Farmers showed considerable response that they had undergone pest and disease control training ( $n=43, 39.8\%$ ). A few smallholder farmers ( $n=32, 29.6\%$ ) had undergone through post-harvest handling training. This finding was similar to Leitgeb et al. (2011), who pointed out that effectiveness of advisory service delivery influences adoption, and that, poor extension service delivery would lead to poor adoption of improved practices in minimizing post-harvest losses of agricultural crop produce. Based on the findings, it's evident that close to half of the respondents ( $n=48, 44.4\%$ ) trained on planting practices which is yet a considerable small proportion. This agrees with the findings of Valdano et al. (2007) and Zossou et al. (2020) who noted that limited access to and use of agricultural information by farmers is one of the key factors limiting social learning and thus advancement of agriculture.

### 3.5 Adoption of Sorghum Production Practices

The adoption of sorghum production practices was evaluated by use of summated scores of five-point Likert-type scale items where 1 denoted never and 5 which denoted always for adoption of sorghum production practices. Table 6 indicates the median scores for descriptive statistics of access and adoption of agricultural advisory services.

Table 6: Adoption of Sorghum Production Practices ( $N = 108$ )

Statement on extent of adoption	Median ( $M$ )
Level of land preparation application practices	4

Extent unto which improved varieties are planted	4
Extent unto which disease management practices are applied	2
Extent unto which ratooning practices are applied	1
Extent unto which fertiliser practices are applied	3
Extent unto which harvesting at maturity practices are applied	4
Extent unto which post-harvest practices are applied	2

The results showed that majority of the respondents had accumulated knowledge from past experiences on land preparation before planting, harvesting crop at maturity and use of improved varieties ( $M=4$ ). This implied that farmers had inherently understood the importance of land preparation prior to planting hence high adoption. This agreed with the recommendation by Yuet al. (2017) who stated that land preparation is important as it helps in killing of weeds, improves soil aeration and destroys different stages of crop pest such as egg, larval, pupae or adult by burying them or exposing them to predators.

Findings from the study showed that post-harvest practices were below the required level ( $M=2$ ), implying a considerable loss of crop after harvest. This study finding is similar to Ragasa et al. (2017) and Kasso & Bekele (2018) who reported that many potentially useful post-harvest technologies for use have been identified in developing countries, though there is a lack of information regarding the costs and financial benefits, since their costs are rarely documented during research studies. Wilson (2011) stated that ratooning management practices helped to avoid the need for land preparation in the second season, which require no new seeds, and also reduce problems related to crop establishment.

### **3.6 Analysis of AAS and Adoption of Sorghum Production Practices**

The study sought to establish the influence of agricultural advisory services on the adoption of sorghum production practices. An independent sample t-test was utilized for testing the hypothesis at the significance index of  $\alpha=0.05$ . T-test analysis on the influence of AAS and adoption of sorghum production practices are shown in Table 7. Out of 108 farmers 41 had access to advisory services while 67 did not.

Table 7: T-test Analysis on Advisory Services and Adoption of Sorghum Practices ( $N = 108$ )

Variables	Farmers with access to advisory services		Farmers with no access to advisory services		<i>df</i>	<i>t</i> -value
	Mean ( <i>M</i> )	<i>SD</i>	Mean ( <i>M</i> )	<i>SD</i>		
Access to advisory services	14.3902	2.15497	14.0149	2.29949	106	0.843
Adoption of sorghum practices	23.6585	2.7935	23.5373	3.13015	106	0.203

To test the influence of AAS amongst smallholder sorghum farmers, an independent samples *t*-test was carried out to establish whether there was statistically significant difference between farmers who access advisory services and those who did not based upon adoption of sorghum production practices. From the results an independent samples *t*-test suggested that smallholder sorghum farmers with access to AAS were relatively similar ( $M=14.3902$ ,  $SD=2.15497$ ,  $n =41$ ) to farmers who do not access AAS ( $M=14.0149$ ,  $SD=2.29949$ ,  $n =67$ ),  $t(106)=0.843$ ,  $p=0.401$ ,  $d =0.1684$ , 95% confidence interval (-0.5076, 1.258). The test met the assumption of homogeneity of variances for the present analysis  $F(106)= 0.069$ ,  $p=0.794$ . The implication of this independent samples *t*-test is that farmers have demonstrated that they have inherently been preoccupied by indigenous knowledge in sorghum production. However, there was no impactful influence, this aspect of adoption may be, the most important in sorghum production to farmer who need to be linked extensively to AAS.

The results (Table 7) were similar with perceptions of farmers concerning accessibility to advisory services with farmers farming objectives where those farmers who have adopted sorghum production practices ( $M=23.6585$ ,  $SD=2.78935$ ,  $n =67$ ) compared to smallholder sorghum farmers who haven't adopted ( $M=23.5373$ ,  $SD=3.13015$ ,  $n =41$ ),  $t(106)=0.203$ ,  $p=0.839$ ,  $d=0.041$ , at 95% confidence interval (1.06051, 1.30295). The test was found to

have met the assumption of homogeneity of variances for the present analysis  $F(106)=0.425, p=0.516$ . With respect to this accomplishment, a  $t$ -statistic assuming homogeneity of variance was calculated. The implication of this independent samples  $t$ -test was that farmers have demonstrated that their way of farming was not dependent on provision of AAS rather through long practice in the field of agriculture.

#### **4. CONCLUSION**

The research intended to establish the extent to which AAS influenced adoption of sorghum production practices amongst smallholder farmers in Tharaka South Sub-County. The results indicated that the influence of AAS on the adoption of sorghum production practices by most smallholder farmers, was very low. Therefore, it was concluded that AAS had no influence on the adoption of sorghum production practices. This may be attributed to overreliance on mass media as the main source of advice since it is subject to provide general information in agriculture that may not necessarily cater for the specific needs of the sorghum farmers. The Ministry of Agriculture, Livestock and Fisheries Development in collaboration with other private institutions and NGO's advisory providers should organize advisory programmes which are farmer centered, and which create a greater impact to the lives of smallholder farmers. Every institution targeting farmers should signal it out that access and utilization of AAS are within reach and will blossom their efforts in their farms.

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## COMPETING INTEREST

Authors have declared that no competing interests exist

## AUTHORS CONTRIBUTION

This work was carried out in collaboration among all authors. Author RON came up with the research gap, designed the study and wrote the first draft of the manuscript. Authors JMM and CAO performed statistical analysis, managed statistical analyses of the study and authors GRM and FKM managed the literature searches and editing of the manuscript. All the authors read and approved the final manuscript.

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