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Assessment of the Impact of Grazing Livestock on Cereal and Tuber Crops Production in Abuja, Nigeria

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Julius Ajah (PhD)

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Abstract
The study assessed the impact of grazing livestock on cereal and tuber crops production in Abuja, Nigeria. Using a multi-stage sampling technique, the study was conducted in five area councils namely Kwali, Kuje, Gwagwalada, Abaji, and Bwari. A semi-structured questionnaire was used for data collection. The data were analysed using a three-way mixed analysis of variance (ANOVA) and results indicated that there were significant locational differences ($p < .01$) in the impact of grazing livestock on cereal and tuber crops production. For cereal crops, the mean responses showed that Kwali Area Council was the most affected while Kuje and Abaji Area Councils had the highest impact in terms of tuber crops. The result also indicated that the level of destruction significantly ($p < .01$) depends on the type of livestock that grazed and the crop cultivated. For cereal crops, cattle and goat/sheep were rated as the most destructive animals while for tuber crops, it was cattle. The least destructive livestock was domestic fowls. Again, among the cereal and tuber crops, maize and cassava were the most affected. The least affected were rice and potato. In terms of cost estimate of crops damaged by grazing livestock, cassava farmers were the most affected, they lost an average of ₦11,745 (US$73) while potato farmers were the least affected, they lost an average of ₦3,679 (US$23). The socio-economic characteristics of the farmers indicated that most of them were relatively young (46 years), married (81.80%) with an average of 7 people per household and had some form of formal education (61.02%). In addition, majority of the farmers had an average farming experience of 26 years, and they cultivated between 1 – 2ha of farm land. Based on the findings, the study recommended that efforts should be geared towards developing grazing routes at community level to minimize the encroachment of grazing livestock onto cultivated land, so as to avoid the destruction of crops and the associated negative socio-economic consequences.

Key words: cereal crops, tuber crops, small-scale farmers, mean responses, locational impact, grazing routes.

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Acronyms

AEO	Agricultural Extension Officer
ANOVA	Analysis of variance
Df	Degree of freedom
FAO	Food and Agriculture Organization of the United Nations
Fig.	Figure
Gwa	Gwagwalada
IFPRI	International Food Policy Research Institute
IFAD	International Fund for Agricultural Development
LGA	Local Government Area (also known as Area Council)
MS	Mean sum of squares
NBS	National Bureau of Statistics
NEARLS	National Agricultural Extension and Research Liaison Services
OPEC	Organization of Petroleum Exporting Countries
p –value	Probability value
SPSS	Statistical Package for the Social Science
SS	Sum of squares
SSA	Sub-Saharan Africa
UNU-INRA	United Nations University- Institute for Natural Resources in Africa
USDI	United States Department of the Interior

1.0 INTRODUCTION

1.1 Background information

Nigeria is one of the countries in Sub-Saharan Africa (SSA) that depends on agriculture (Ijirshar, 2015) to feed her population of about 163 million (British Council Nigeria, 2012). Agriculture is an important source of income and a livelihood option for many households. The major actors in the agricultural value chain are small-scale farmers who constitute substantial proportion of the population and are scattered all over the habitable regions of the country. They constitute about 70 percent of those who are in agricultural production (Idowu, Ayoola, Opele and Ikenweiwe, 2011) and they produce about 90 percent of the total agricultural output in the country (IFAD, 2007). The small-scale farmers are diverse and comprise of both male and female farmers in different age categories. They have different abilities depending

Fig. 1: Pastoralists moving with their livestock
Source: Available online at:
http://www.channelstv.com/2014/04/24/delta
Accessed April 10, 2015

on circumstances that lead them into agriculture. Their significant contribution to agriculture and sustainable development is one of the reasons they are placed at the center stage of research and development programmes by the Nigerian agricultural policy-makers and planners. Because of their role in the economy, the small-scale farmers are key players in agricultural development as they dominate and determine total output and productivity of the country. They have the freedom and privileges to produce whatever crop or livestock they desire except those banned by law. They can, as a matter of occupation or interest, embark on crop and/or livestock production. Some engage in agriculture as hobby while others regard it as their main occupation or business. These farmers are given recognition to the extent that almost all international and national programmes aimed at promoting agriculture and rural development are designed to capture their interest and motivate them to improve their scale of operations and overall productivity. The significant role that small-scale farmers play in Nigeria's agriculture and economy shows that they are indispensable (particularly in the short run), hence they deserve continued and unconditional support.

The importance of small-scale farmers in agricultural development cannot be overemphasized. While every effort is being made to encourage and improve their productivity in both livestock and crops in the country, one of the greatest challenges being experienced is the destruction of crops by grazing livestock (Gefu and Gills, 1990; Adebayo and Olaniyi, 2008; Ofuoku and Isife, 2009; Adoji, 2013; Okoli and Atelhe, 2014). The grazing livestock (cattle, goat, sheep) can encroach into crop fields and destroy crops at any developmental stage - they can eat the stems, seeds, flowers, leaves, tubers or the roots of the crops. However, not all livestock production systems result in

the destruction of crops. The destruction depends on whether it is intensive, semi-intensive or extensive system that is adopted by the farmers.

Extensive system of livestock production refers to a system whereby the animals are allowed to roam and look for food unrestricted (Ezeibe, 2010). On the other hand, semi-intensive system allows for good control of feeding, management and the animals are more protected. Intensive system is a total confinement of the livestock (Ezeibe, 2010, Devandra and Fuller, 1989). In some instances, cattle, goats and sheep can be reared by nomadic herdsmen (Blench, 2010) who guide the animals as they graze on pasture (Fig. 1 and Fig. 2), while in some, the livestock move freely with little or no form of restriction (Fig 3). Of all the systems, the predominant among the small-scale farmers in Nigeria is the extensive or free range system (Ezeibe, 2010; Nweze, Otuma, Ekwu and Oga, 2003; Ovwigho, Mmereole, Udeh and Akporhuarho, 2009). This poses a serious challenge, as the livestock graze without proper guidance, with crop fields being an easy target. Unfortunately, some of the livestock can destroy crops even when they are guided by nomadic herdsmen. The problem is compounded because most crop fields are not fenced and this results in extensive destruction of crops. The inability of crop farmers to fence their farms coupled with the cultivation of small portions of land that are characterized by low yields per hectare (Kolawale and Ojo, 2007) make them highly vulnerable.

Ironically, while the livestock farmers have nothing to lose in some cases, the crop farmers are at the receiving end as they suffer crop failure and/or low productivity (Ofuoku and Isife, 2009). Contrastingly, in advanced economies with organized farms, the symbiotic relationship between crop farmers and livestock producers is very encouraging and maintained to the extent that both enjoy mutual benefits. For those who practice extensive system of livestock production, there will be proper grazing routes that make it very difficult for grazing livestock to damage crops on farm lands. But in Nigeria, the adoption of extensive system by livestock farmers coupled with absence and/or non-adherence to grazing routes has created problems between crop and livestock farmers. The resultant effect of this scenario are crop damages (and vice versa) with multiple socio-economic consequences. In other words, the predominance of extensive system of livestock production coupled with the absence and/or non-adherence to grazing routes, have become major threats to crop production and this is contrary to the concept of sustainable agricultural development and green business.

Fig. 2: Domestic fowls grazing around home
Source: Available online at: https://camel4all.wordpress.com/2014/03/04/ Accessed April 10, 2015

In this context, another worrisome issue is the difficulty in computing the extent and quantity of crops damaged annually in Nigeria. This is partly due to lack of farm records reflecting such crop damages. The extent of damage can only be imagined by looking at the stock populations for cattle, goat, sheep and poultry birds which were estimated by the National Bureau of Statistics (NBS, 2012) as 16,722,170, 57,937,176, 36,372,233 and 201,928,991 respectively. Though these stock figures do not give specific populations of livestock under different grazing systems, they help to give an idea of the number of livestock that are reared in Nigeria.

Fig. 3: Grazing goat and sheep
Source: Available online at: http://www.ilri.org/aggregator/sources/275 Accessed April 10, 2015

Apart from crop damages on farm land, several other studies have shown that grazing livestock have other negative consequences on the environment. First, they destroy young trees, herbaceous plants and grasses thereby causing loss in biodiversity (FAO, 2002; Marty, 2005; Enete and Amusa, 2010; Ayanda, 2013). The empirical evidence shows that grazing livestock affects biomass (Clary and Kinney, 2002), decreases species richness and composition (Champion, Beadel and Dugdale, 2001; Touzard and Clement, 2001; Greviliot and Muller, 2002) and kills birds by trampling on their nests

(Poponik and Giuliano, 2000). The impact on biodiversity is enormous, for instance, Khanal (2009) estimated that 25 – 42 percent of species habitat have been lost, with effects on both food and non-food crops. This is in line with the argument by FAO (2002) which indicated that the extent and method of agriculture, forestry, and fishing are leading causes of loss of the world's biodiversity. FAO further noted that over stocking land with grazing animals cause desertification and loss of plants biodiversity. Unfortunately, the livestock farmers may not be too concerned with the implications of loss of biodiversity. They are more likely to be conscious of the pastures, water availability, disease-free and a conducive environment for their herds.

Second, studies also showed that grazing livestock affect soil, output and productivity (Ofuoku and Isife. 2009; Gefu and Gills, 1990). A study by McDowell, Drewry, Muirhead and Paton (2005) showed that cattle grazing pastures on sloping land contribute to run-off, soil erosion and loss of nutrients. Similar studies by Drewry, Cameron and Buchan (2008), Greenwood and McKenzie (2001) showed that treading on soil by livestock may lead to increased soil strength and bulk density, reduced soil porosity and hydraulic conductivity. Bell and Gilkes (2010) further demonstrated that rainfall infiltration was increasingly affected by grazing livestock with up to 10 percent reduction in grain yield. They attributed the effects to the reduction in soil surface conductivity due to compaction of soil surface by grazing livestock. A similar report by Radford, Yule, Braunack and Playford (2008) also indicated that there was significant reduction in subsequent crop growth and production after treading by livestock. The study added that grazing livestock increased soil compaction resulting in restricted movement of water into and through soil profile. In one way or the other, all these studies concur to the fact that inappropriate farming methods, deforestation

and overgrazing land result in soil depletion and erosion (FAO, 2002; Arulebu and Ayayi, 2011). This calls for an elaborate approach to properly manage livestock production so as to minimise its negative impact on the environment.

Third, the most critical issue identified by numerous scholars (e.g. Nyong and Fiki, 2005; Tonah, 2006; Adebayo and Olaniyi, 2008; Blench, 2010; Abbass, 2012; Adoji, 2013; Ayanda, 2013; Audu, 2013, 2014; Okoli and Atelhe, 2014) is the conflict arising from the destruction of crops by grazing livestock which threatens the unity and peaceful co-existence in various communities across the country. Other studies also indicated that grazing livestock contaminate water sources in rural communities in Nigeria (FAO 2002; Ofuoku and Isife, 2009). It is noteworthy to point out that the impact of grazing livestock on water points is not only in Nigeria but even in countries such as the United States of America (USA). For instance, USDI (1994) showed that about 80 percent of the damage incurred by streams and riparian systems in the arid environments of the USA arises from grazing livestock. According to Belsky et al. (1999), stream and riparian damage resulting from livestock grazing occurred as a result of alterations in watershed hydrology, soil compaction and erosion, riparian vegetation destruction, and water quality impairments. It also leads to indiscriminate bush burning that negatively affects the environment (Ofuoku and Isife, 2009).

From the foregoing, there is no doubt that scholars have tried to reveal the impact of grazing livestock on the environment and its socio-economic consequences, but none specifically addressed how small-scale farmers perceived the impact of grazing livestock on crop production. Most of the

studies were focused mainly on the impact of cattle, goat and sheep that are reared by pastoralists with no emphasis on domestic fowls which also have the potential to destroy crops and induce conflict in the society. Hence, the need for this study to assess the impact of grazing livestock on cereal and tuber crops production in Abuja, Nigeria.

1.2. Objectives of the study

The broad objective of the study is to assess the impact of grazing livestock on cereal and tuber crops in Abuja, Nigeria. Specific objectives are to:

1. assess farmers' perception of impact of grazing livestock on some cereal and tuber crops,
2. determine the cereal and tuber crops that are mostly affected by grazing livestock,
3. determine the livestock (cattle, goat/sheep, domestic fowls) that farmers perceived as most destructive during grazing,
4. determine if there are locational differences in impact of grazing livestock on cereal and tuber crops production,
5. estimate the costs of damage by grazing livestock on cereal and tuber crops, and
6. describe the socio-economic characteristics of small-scale farmers.

1.3 Research questions

The following questions were addressed in the study:

1. How do small-scale farmers perceive the impact of grazing livestock on the production of cereal and tuber crops?
2. Which livestock impacts more on the cereal and tuber crops?

3. Which of the cereal and tuber crops is most affected by grazing livestock?
4. Are there locational differences on the impact of livestock on cereal and tuber crops?
5. Does the impact of grazing livestock depend on type of crop cultivated as well as type of livestock reared in a given location?
6. What are the estimated costs of crops destroyed by grazing livestock?
7. What are the socio-economic characteristics of crop farmers in the study area?

1.4. Hypotheses

Test of hypotheses was done based on variables stated in equation 1 under the data analysis section. To avoid repetition of the hypotheses for both cereal and tuber crops, the seven hypotheses are stated using cereal crops as example.

Ho: There is no significant locational difference in the impact of grazing livestock on cereal crops ($\mu_{Kwali} = \mu_{Kuje} = \mu_{Gwagwalada} = \mu_{Abaji} = \mu_{Bwari}$)

Ho: The impact of grazing livestock does not significantly depend on type of cereal crop cultivated (crop type). A test of 'main effect' of crop type ($\mu_{Maize} = \mu_{Rice} = \mu_{Sorghum} = \mu_{Millet}$)

Ho: The impact of grazing livestock on cereal crops production does not significantly depend on type of livestock reared (livestock type). A test of 'main effect' of livestock type ($\mu_{Cattle} = \mu_{Goat/Sheep} = \mu_{Domestic\ Fowls}$).

Ho: There is no significant interaction between location and crop type ($\mu_{Kwali\text{-}Maize} = \mu_{Kwali\text{-}Rice} = \mu_{Kwali\text{-}Sorghum} = \mu_{Kwali\text{-}Millet} = \ldots\ \mu_{Bwari\text{-}Maize} = \mu_{Bwari\text{-}Rice} = \mu_{Bwari\text{-}Sorghum} = \mu_{Bwari\text{-}Millet}$).

Ho: There is no significant interaction between location and livestock type ($\mu_{Kwali\text{-}Cattle} = \mu_{Kwali\text{-}Goat/Sheep} = \mu_{Kwali\text{-}Domestic\ Fowls} = \ldots\ \mu_{Bwari\text{-}Cattle} = \mu_{Bwari\text{-}Goat/Sheep} = \mu_{Bwari\text{-}Domestic\ Fowls}$).

Ho: There is no significant interaction between livestock type and crop type ($\mu_{Cattle\text{-}Maize} = \mu_{Cattle\text{-}Sorghum} = \mu_{Cattle\text{-}Rice} = \mu_{Cattle\text{-}Millet} = \ldots\ \mu_{Domestic\ Fowls\text{-}Maize} = \mu_{Domestic\ Fowls\text{-}Sorghum} = \mu_{Domestic\ Fowls\text{-}Rice} = \mu_{Domestic\ Fowls\text{-}Millet}$).

Ho: There is no significant interaction of location, livestock type and crop type.

1.5. Significance of the study

Agriculture, be it in the form of crop or livestock production, is one of the major components of green growth business in rural communities in Nigeria and other countries. For example, in Ethiopia, agriculture is a major component of green business and they are targeting increased productivity, enhanced food security, job creation and stability of export income (Federal Democratic Republic of Ethiopia, 2011). This implies that in Ethiopia, any factor that affects agriculture has affected a major component of green business. In many African countries, agricultural production is one of the major sources of livelihood in rural communities, and it can be tailored to be an important vehicle towards achieving a green economy.

UNU-INRA is interested in identifying factors that affect the conservation of biodiversity in Africa and other parts of the world. In this regard, there is need to determine if grazing livestock significantly affect crop production. This calls for serious attention because crops are major components of biodiversity in any environment. Any activity that affects crop production will directly or indirectly affect biodiversity conservation.

Every country is working towards preventing, controlling or eliminating factors that negatively affect their ecosystems and also factors that hinder them from achieving sustainable development. In order to design appropriate measures to achieve this, there is need to have a proper understanding of such factors. This requires proper research that integrates both qualitative and quantitative data so as to have an in-depth understanding

of some of the factors that affect the ecosystem and sustainable development, hence the importance of this study. The findings of this study will help in the formulation of policies, strategies and programmes that will help in tackling the associated challenges and contribute to the overall green economy objective in Nigeria and other countries facing similar challenges. The outcome will have many benefits including poverty alleviation effects. As noted by Smulders and Withagen (2012), measures that improve natural resource management, prevent pollution and reduce vulnerability to environmental risks will tend to benefit the poor.

Finally, the study will help (especially) agricultural policy makers and planners in Nigeria and other countries to appreciate the challenges confronting crop production in an environment where there is absence and/or non-adherence to grazing routes. That is, rather than realising mutual benefits between crop and livestock production, they become significant constraints to each other.

2.0 METHODOLOGY

2.1 Study area

The study area is Abuja, Nigeria. It is located between latitudes 8^0 25` and $9^0$ 25` North of the Equator and longitudes 6^0 45`and $7^0$ 45` East of Greenwich.

The territory covers an area of 760,700 hectares of land (NBS, 2012) lying in the centre of the country. Abuja is bordered on all sides by four States namely: Niger, Nasarawa, Kogi and Kadunna (Dawan, 2000). The territory is currently made up of six Area Councils - Gwagwalada, Abuja Municipal, Abaji, Kuje, Bwari and Kwali (Fig. 30 and Fig. 31). The choice of Abuja is very important because it is situated within the Savannah region with moderate climatic conditions which has tremendous potential for supporting both crop and livestock production (Balogun, 2001). Abuja experiences two major seasons – wet and dry seasons. It has an annual average temperature ranging from 22.0°C – 37.0 °C while annual average rainfall varies from 1.175 – 1.472 millimeters (NBS, 2010a). The vegetation is dominated by herbaceous plants which are occasionally interspersed with shrubs (Tanko and Muhsinat, 2014).

2.2 Sampling technique

The study area (Abuja) was purposively selected because it has socio-demographic, climatic and ecological potential for supporting agriculture. The target population of the study includes all rural small-scale crop farmers. For effective coverage of the study area, a multi-stage sampling technique was adopted. Collecting and analysing data down to each area council is vital because Boyle (2004) argued that data and research at the rural level provide relevant information needed for making decisions. In the first stage, 5 out of the 6 Local Government Areas (LGA) also called Area Councils (Abaji, Gwagwalada (Gwa), Kuje, Kwali, Bwari) were purposively selected because they were rural communities dominated by both livestock and crop farmers. In the second stage, five rural communities were randomly selected from

each of the five LGAs giving a total of 25 communities. From each of the 25 rural communities (third stage), 20 crop farmers were randomly selected and interviewed giving a total of 500 respondents. Out of the 500 questionnaires, 434 were properly filled and used for the study.

2.3 Instrument design/data collection

Semi-structured questionnaires were used for data collection. In the questionnaires, questions on some demographic characteristics of the farmers were included. To quantify the impact of grazing livestock on cereal and tuber crops, a rating scale of 0 - 4 was used. In the questionnaires, farmers were asked to rate the impact of grazing livestock on cereal and tuber crops production using: very highly destructive (4), highly destructive (3), moderately destructive (2), least destructive (1) and not destructive at all (0). Shah and Madden (2004) highlights the importance and validity of using rating scale in impact assessment. The responses were used to run analysis in line with the method adopted by Ajah (2014, 2015), Robert (2011), Gray and Kinnear (2011) and Field (2005). Also, the farmers were asked to estimate the cost of damages caused on their crops by grazing livestock. To reach the farmers, agricultural extension officers (AEO) covering the communities were contacted and they served as enumerators. These AEOs had experience in undertaking data collection as they had previously participated in similar exercises. They were also trained for this particular study, so that they understand the objectives of the study and how to administer questionnaires to farmers in the communities. The enumerators were properly mobilized to enable them perform quality jobs while the researcher supervised the process. The problem of language was solved because most of the

enumerators were from the selected communities and they speak and understand the local languages. Secondary data were collected from journals, books and other relevant materials.

2.4. Data analysis

Quantitative and qualitative methods were employed in data analysis. For a better understanding of the impact of grazing livestock on cereal and tuber crops, the analysis was done in three parts. The impacts on cereal and tuber crops were assessed separately, then with pooled data (i.e. both cereal and tuber crop data). A three-way mixed analysis of variance (ANOVA) (Field, 2005) was used for the analysis and it is expressed mathematically as:

$$Y_{ijtk} = \mu + L_i + C_i + S_t + LC_{ij} + LS_{it} + CS_{it} + LCS_{ijt} + e_{ijtk} \quad (1)$$

Where:

Y_{ijtk} = Individual farmer's response on the impact of grazing livestock on cereal crops production.
-*i* denotes the level of factor L
-*j* denotes the level of factor C
-*t* denotes the level of factor S
-*k* denotes the kth observation in cell or treatment (*i, j, t*)

μ = population mean
L_i = impact as a result of differences in location (Kwali, Kuje, Gwagwalada (Gwa), Abaji, Bwari). This measures the main effect of location.
C_i = Crop type - this measures the main effect of crop type, i.e., impact due to type of cereal crops cultivated (maize, rice, sorghum, millet)
S_t = Livestock type - this measures the main effect of livestock type, i.e., impact due to type of grazing livestock (cattle, goat/sheep, domestic fowls)
LC_{ij} = interaction between location and crop type

LS_{it} = interaction between location and livestock type
CS_{it} = interaction between crop type and livestock type
LCS_{ijt} = interaction of location, crop type and livestock type
e_{ijtk} = error term

The model hypothesizes that the impact of grazing livestock on cereal (or tuber) crops production depends on three factors - the location of the farmer in Abuja, type of livestock reared and type of cereal (or tuber) crop cultivated. Crop type and livestock type were measured repeatedly hence they are called "within factor variables". Crop type for cereals has 4 levels (maize, rice, sorghum, millet) while tuber has 3 levels (yam, cassava, cassava). Livestock type has three levels (cattle, goat/sheep, domestic fowls). Location (a between factor variable) has 5 levels (Kwali, Kuje, Gwagwalada (Gwa), Abaji, Bwari). By implication, the model states that the impact of grazing livestock on cereal (or tuber) crops production (Y_{ijtk}), depends on location of the farmer in Abuja (L_i) type of crop cultivated (C_i), type of livestock reared (S_t), both location and type of crop cultivated (LC_{ij}), both location and type of animal reared (LS_{it}), both livestock type and crop type (CS_{it}), and the joint effect of location, livestock type and crop type (LCS_{ijt}). The μ is the population mean which has no effect on the scores obtained and does not contribute to any variation in the observed differences (Aggarwal, 2002). The error term is given by e_{ijtk}. SPSS 21.0 was used to run the analysis and mean separation was done using Bonfenori model (Field, 2005). It was tested at 5 percent probability level.

3.0 RESULTS AND DISCUSSION

3.1 Analysis of impact of grazing livestock on cereal crops production

Table 1 shows results of the 3-way mixed ANOVA carried out to assess the impact of grazing livestock on the cereal crops. The model provides the opportunity to look at the data from two perspectives i.e. assessing the main effects of the factors and their interaction effects. It should be noted that each row in the Table 1 provides answer to each of the hypotheses stated and the objectives of the study. Each of the factors and their interactions were interpreted separately, in order to enhance the comprehension of the results. That is, each of the "sources of variations" as reflected in Table 1 was interpreted separately.

Table 1 ANOVA results of the impact of grazing livestock on cereal crops production

Sources of variation	Df	SS	MS	F-cal	P-value
Livestock type	2	269.10	134.55	142.00	.00
Livestock type∗location	8	143.52	17.94	19.07	.00
Error (Livestock type)	858	807.23	0.94		

Crop type	3	1004.98	334.99	512.89	.00
Crop type∗location	12	1113.16	92.76	142.03	.00
Error (crop type)	1287	840.60	0.65		
Livestock type∗crop type	6	122.30	20.34	60.43	.00
Location∗livestock type∗crop type	24	131.31	5.47	16.22	.00
Error (livestock type∗ crop type)	2574	868.31	0.34		
Location	4	171.29	42.82	147.71	.00
Error (location)	429	124.37	0,29		

Source: Survey data analysis, 2015

3.1.1: Impact of grazing livestock on cereals production in different locations

The results on the impact of grazing livestock on cereal crops production in different locations (main effect of location) is shown in Table 1. It shows how the farmers rated the impact of livestock on cereal crops production in different locations. The question to be answered is: are there significant locational differences in the impact of grazing livestock on cereal crops production? That is, without reference to any particular crop or livestock, how did farmers in each area council rated or perceived the impact of grazing livestock on cereals production? It tests the hypothesis which states that there are no significant locational differences in the impact of grazing livestock on cereal crops production ($\mu_{Kwali} = \mu_{Kuje} = \mu_{Gwagwalada} = \mu_{Abaji} = \mu_{Bwari}$). The result, $F(4, 429) = 147.71$, $p = .00$, showed that there were significant locational differences ($p < .01$) in impact of grazing livestock on

cereal crop production hence the rejection of the null hypothesis. The mean responses (Fig. 4) showed[1] that, of all the locations, Kwali Area Council seemed to be the most affected by the impact of grazing livestock as the farmers in that area had a mean response that was significantly ($p < .05$) higher than the perceived impact in other locations. The farmers' ratings indicated that the least affected Area Council was Gwagwalada followed by Kuje. The implication of the magnitude of the mean response in Gwagwalada Area Council is that impact of grazing livestock was not a major constraint limiting the production of cereal crops. Even though the magnitude of impact might seem to be relatively low, this should be seen as a threat to sustainable agricultural development in the area. The locational differences may be attributed to the availability and use of grazing routes. Abbass (2012) stated that there were 4125 grazing routes in Nigeria including Abuja. In terms of policy formation, this result is very important if government wants to take decisions without reference to any particular crop or livestock in each location. However, subsequent results will reveal peculiarities in some locations with respect to livestock and crops.

[1] N.B. In Fig. 4 and all other figures showing bars of mean response, the alphabetical letters on top of the bars seek to show the significance of differences, with the same alphabetical letter on two or more bars implying no significant difference between them, while difference letters show significant differences.

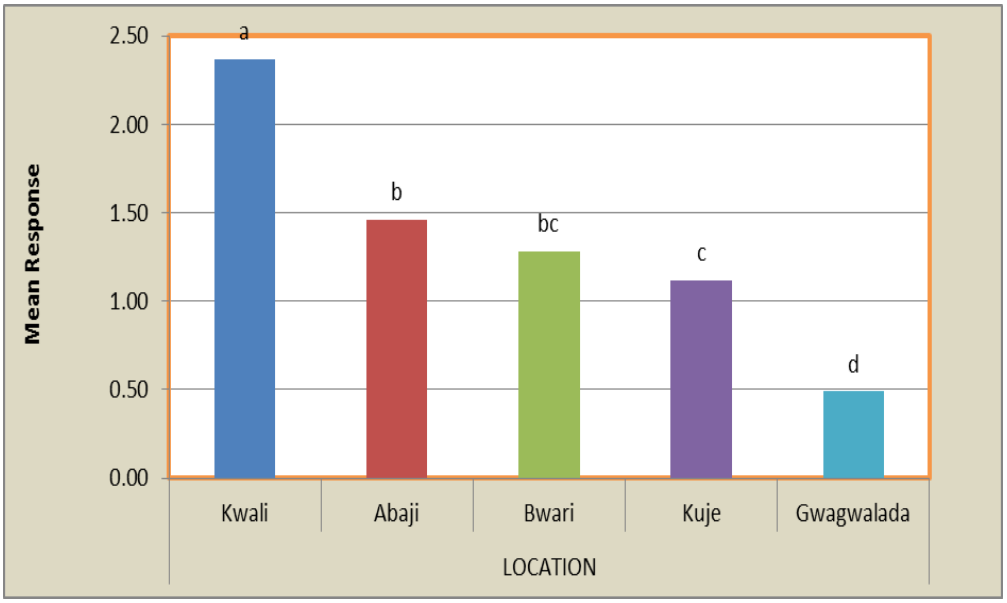

Fig. 4: Farmers' rating of impact of livestock on cereal crops production in different locations (main effect of location)
Source: Survey data analysis, 2015

3.1.2: Impact on cereal crops production due to differences in livestock type

The effect of different livestock type on cereal crops production was also assessed. The question is: regardless of location (area councils) and crop type, did the impact of grazing livestock on cereal crops depend on livestock type? It tests the hypothesis which states that impact of grazing livestock on cereal crops production does not depend on type of livestock reared ($\mu_{cattle} = \mu_{goat/sheep} = \mu_{domestic\ fowls}$). The result, $F(2, 858) = 142.00$, $p = .00$, indicates that the impact of grazing livestock on cereal crops production significantly ($p < .01$) depended on the type of livestock reared. In other words, irrespective of location and crop type, the impact of some animals (cattle, goat/sheep, domestic fowls) on cereal crops production significantly differed

hence, the rejection of the null hypothesis. The mean separation (Fig. 5) shows that while the mean perceived impact of cattle and goat/sheep on cereal crops production did not significantly differ ($p > .05$) from each other, they were both significantly higher than that of domestic fowls. This shows that farmers rated the impact of cattle and goat/sheep on cereal crops production almost the same. The result also shows that cattle and goat/sheep were the most destructive animals while domestic fowls were the least. This is in line with the findings of Ofuoku and Isife (2009) as well as, Adebayo and Olaniyi (2008) who indicated that the impact of cattle, goat and sheep on crops was a major source of conflict between the pastoralists and the crop farmers. Although other sources of conflict have also been identified by other scholars (Abbass, 2012; Okoli and Atelhe, 2014), but crop destruction is a major factor.

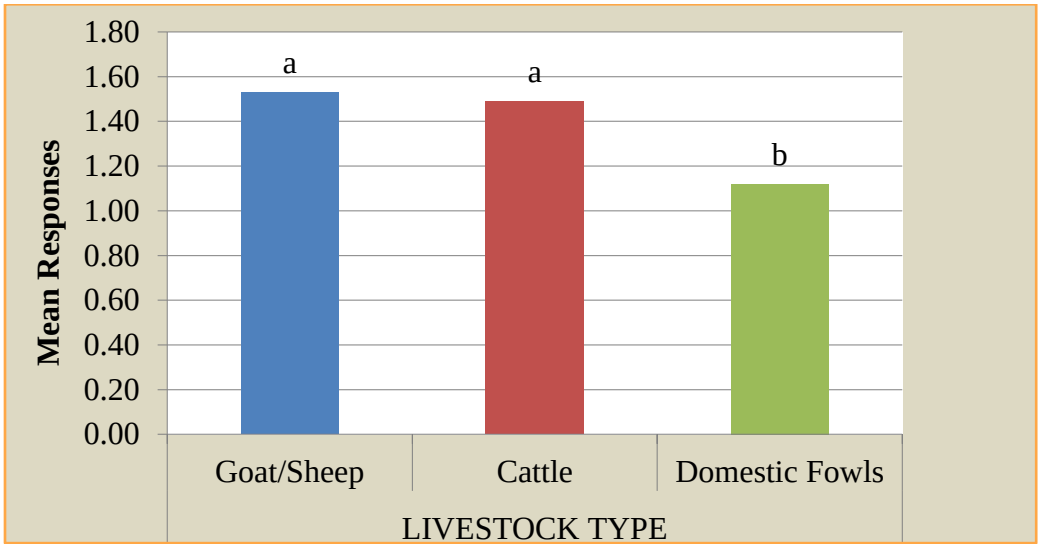

Fig. 5: Farmers' rating of impact of each livestock on cereal crops production (main effect of livestock type)

Source: Survey data analysis, 2015

3.1.3: Impact of interaction between location and livestock type on cereals production

Table1 also shows the result of interaction between location and livestock type (livestock type∗location). It provides information on how the farmers rated the impact of each livestock type on cereal crop production in each area council. The question is: without reference to crop type, did the impact of each of the livestock types (cattle, goat/sheep, domestic fowls) on all cereal crops differ in each location (Kwali, Kuje, Gwagwalada, Abaji, Bwari). It tests the hypothesis which states that there is no significant interaction effect between location and livestock on cereal crops production ($\mu_{Kwali\text{-}cattle} = \mu_{Kwali\text{-}Goat/Sheep} = \mu_{Kwali\text{-}Domestic\ Fowls} = \ldots\ \mu_{Bwari\text{-}Cattle} = \mu_{Bwari\ Goat/sheep} = \mu_{Bwari\ Domestic\ Fowls}$). The result, $F(8, 858) = 19.07$, $p = .00$, shows that there was significant ($p < .01$) interaction between location and the type of livestock reared, hence the rejection of null hypothesis. This shows that the impact of some animals on cereal crops production significantly ($p < .01$) differed in some Area Councils (locations). Mean separation was done separately to identify the livestock that was rated as most destructive in each location. The result (Fig. 6) indicates that, in Kwali Area Council, the impact of cattle on cereal crops production was significantly ($p < .05$) higher than that of goat/sheep, while the mean of goat/sheep was also significantly ($p < .05$) higher than that of domestic fowls. This shows that cattle were rated as the most destructive livestock in Kwali Area Council while domestic fowls were the least. The rating of the impact of livestock on cereal crop production in Gwagwalada Area Council was similar to that in Kwali Area Council but on the contrary, it differed with those of Kuje, Abaji and Bwari Area Councils.

In Kuje and Bwari Area Councils, goat/sheep were rated as the most destructive animals while in Abaji Area Council, both cattle and goat/sheep were rated the same. In all the Area Councils, farmers rated the impact of domestic fowls on cereal crops production as the least. This result is similar to the one reported by Ajah (2012) though the study differed because of non-inclusion of crop type. The result suggests that livestock rearing especially cattle and goat/sheep may be more predominant in some area councils compared to others. Ofuoku and Isife (2009) stated that livestock farmers are transhumance in their quest for pasture and other necessities of life but the more the number of livestock in a location, the more likelihood of interaction with crop farms.

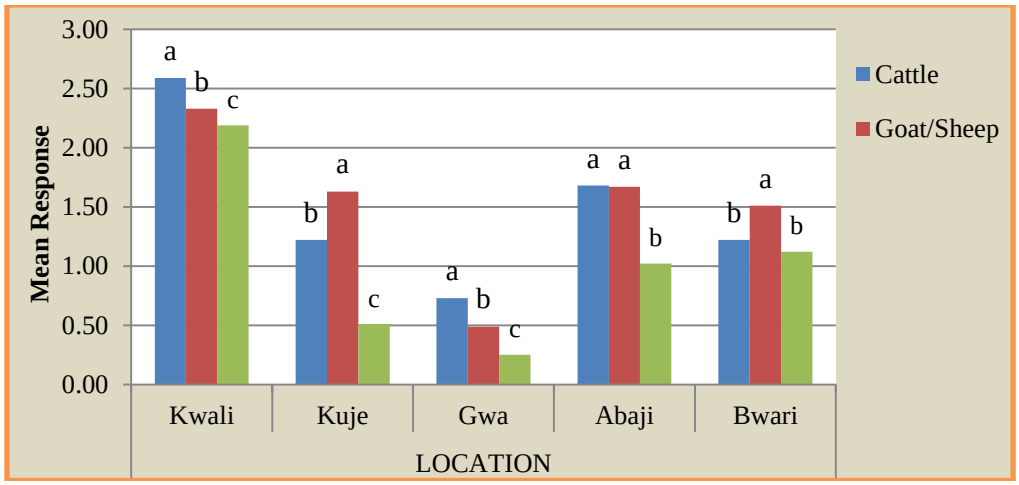

Fig. 6 Farmers' rating of impact of each livestock on cereal crops production in each location (interaction of location and livestock type)

Source: Survey data analysis, 2015

3.1.4: Impact of grazing livestock on cereal crops production by crop type

The impact of grazing livestock was also assessed by crop type and it is denoted by "Crop type" in Table 1. The question here is: does the impact of grazing livestock depend on type of cereal crop cultivated? It tests the hypothesis which states that the impact of grazing livestock on cereal crops production does not depend on type of crops cultivated ($\mu_{Maize} = \mu_{Rice} = \mu_{Sorghum} = \mu_{Millet}$). This is more like a test of preference, which relates to the observation by Kie and Boroski (1996) that cattle selectively forage on grasses**.** Cereal crops are different in many respects and there is likelihood that animals may prefer one or some of the cereal crops to others. The result, $F(3, 1287) = 512.89$, $p = .00$, indicates that the main effect of crop type was significant ($p < .01$), leading to the rejection of the null hypothesis. The implication of this is that the impact of grazing livestock significantly depends on the type cereal crop cultivated. On the other hand, it also implies that some of the animals preferred some cereal crop to others or that some are by nature, more vulnerable to destruction by grazing livestock. Mean separation (Fig. 7) indicates that maize was the most affected cereal crop. The impact on maize was significantly ($p < .05$) higher than any other cereal crop.

The second most affected crop was sorghum and the impact on sorghum was significantly ($p < .05$) higher than that of millet. The least affected was rice and this may be attributed to the fact that rice is mostly planted in *fadama* areas. These areas are relatively swampy or water-logged (Dalil and Nsini, 2014), of which livestock like goats and sheep tend to avoid water during grazing (Forsyth, Coomes, Nugent and Hall, 2002).

Looking at the results, it can be seen that the farmers rated maize as the most affected crop followed by sorghum, millet and rice. If we look at the result on the basis of preference, it can be inferred that grazing livestock generally preferred maize crop to other cereals or that maize was more vulnerable to destruction by grazing livestock. Rice was rated as the least affected but ironically, cost estimate of damaged crops (Fig. 29) showed that rice farmers were the most affected. The difference can be attributed to the relatively high cost of rice per kilogram compared to other cereals in Nigeria. Rice is one of the most important cereal crops and the study by Ahmad, Samuel, Makama and Kiresur (2015) showed that the compound growth rate for rice between 1982 and 2012 was 2.10 for area, 1.61 for production and –0.483 for productivity. The implication of the results according to the scholars is that there was positive increase in area under production but a negative and slow reduction in the productivity of rice within the period. This shows that there are factors limiting the productivity of the rice farmers, of which the negative impact of grazing livestock may have been one of those factors. Apart from rice, the rating of impact of livestock on maize, sorghum and millet tallied with the cost estimate of damaged cereal crops. This shows the validity of application of rating scale on impact assessment and supports the report by Shah and Madden (2004) who applied ordinal data in designed factorial experiments.

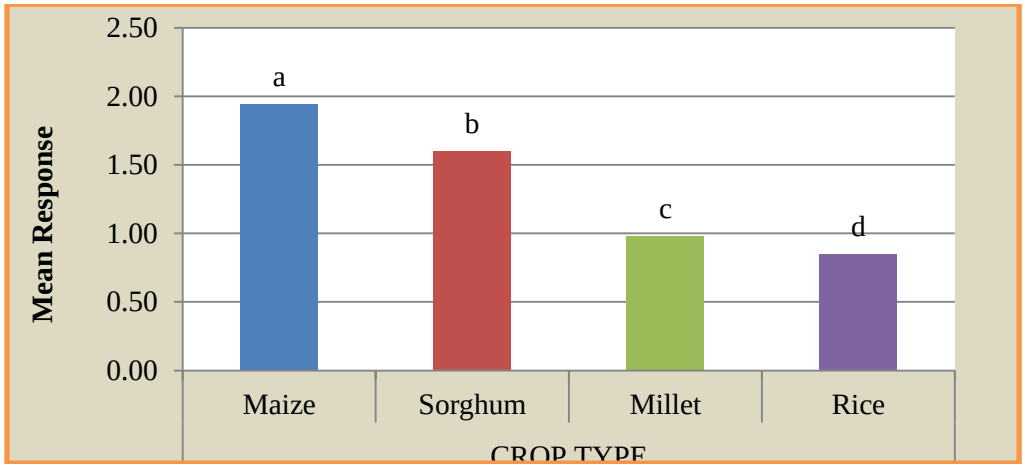

Fig. 7 Farmers' rating of impact of livestock on each cereal crop (main effect of crop type)
Source: Survey data analysis, 2015

3.1.5: Impact of interaction between location and crop type on cereals production

The effect of interaction between location and crop type on cereals production (location∗crop type) is shown in Table 1. This interaction shows farmers' rating of impact of livestock on each cereal crop in each area council. The question is: irrespective of the livestock type, in which of the Area Councils (locations) was each of these cereal crops mostly affected (destroyed) by grazing livestock? It tests the hypothesis which states that there is no significant interaction between location and crop type. In other words, it tests the hypothesis that the impact of grazing livestock on each cereal crop does not significantly differ in each Area Council. The results, $F(12, 1287) = 142.03$. $p = .00$, shows that there was a significant ($p < .01$) interaction effect between location and crop type hence, the null hypothesis was rejected. Mean separation (Fig. 8) carried out for each location indicates

that in Kwali Area Council, the most affected crop was sorghum and the impact on sorghum was significantly ($p < .05$) higher than the impact on maize. The impact on maize was significantly higher than that of rice. Similarly, the impact on rice was significantly ($p <. 05$) higher than that of millet. On the contrary, maize was the most affected crop in Kuje Area Council and the impact on maize was significantly ($p < .05$) greater than that of millet (the second most affected crop). The impact on millet was significantly ($p <. 05$) higher than that of sorghum, while that of sorghum was higher than that of rice. Looking at Gwagwalada, Abaji and Bwari Area Councils, it can be seen that there were variations in the impact of grazing livestock on the different cereal crops.

It is important to note that apart from Kwali Area Council, the most affected crop was maize while the least affected crops varied from one location to another. For instance, in Kwali and Gwagwalada Area Councils, the least affected cereal crops were millet while in Kuje, Abaji and Bwari Area Councils it was rice. The results suggest that there were differential challenges in the production of cereal crops in all the locations. This is discouraging because Nigeria is one of the countries that depend on the importation of cereal crops to meet her local demand (Vaughan, Afolami, Oyekale and Ayegbokiki, 2014). It is noteworthy to highlight that small-scale farmers are the major producers of these crops (Oyeyika and Bolannwa, 2009).

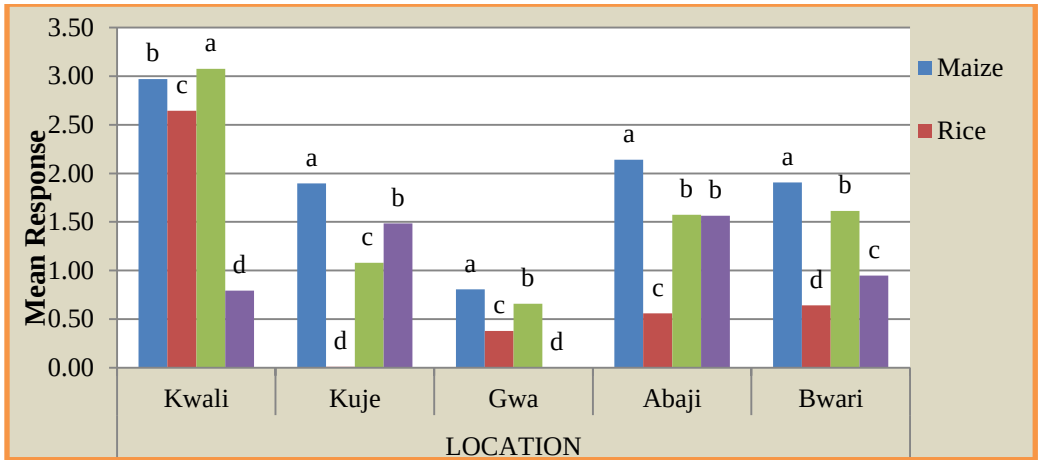

Fig. 8 Farmers' rating showing most affected cereal crop by grazing livestock in each location (interaction of location and crop type)
Source: Survey data analysis, 2015

3.1.6: Impact of interaction between livestock type and crop type on cereals production

The effect of interaction between livestock type and crop type (livestock type∗crop type) on cereals production is shown in Table 1. This interaction provides information on how the small-scale crop farmers rated the impact of each animal on each cereal crop. The question here is: in the entire study area (irrespective of location), which livestock affected or was associated with the destruction of each cereal crop more than the other? In other words, was a particular cereal crop more vulnerable to destruction by a particular grazing livestock? It tests the hypothesis which states that there is no significant interaction effect between livestock type and crop type. The result, $F(6, 2574) = 60.43$, $p = .00$, shows that there was a significant ($p < .01$) interaction effect between livestock type and crop type. This implies that some of the animals were known to destroy (or eat) some of the crops

more than others in the study area. Mean separation (Fig. 9) revealed that maize was more vulnerable to destruction by cattle and goat/sheep than domestic fowls. The second most affected crop was sorghum and the mean rating indicated that it was damaged mostly by cattle and goat/sheep. The impact of domestic fowls on sorghum and maize was also relatively high but in the whole interaction, its impact on millet was the least. The relative vulnerability of maize and sorghum to destruction by the animals presents a big challenge which needs immediate action. FAO (2002) predicted that developing countries like Nigeria would produce only 85 percent of her cereal needs with net import of about 265 million tonnes annually. This import bill can be reduced if the negative impact of grazing livestock on crop productivity and other challenges are addressed.

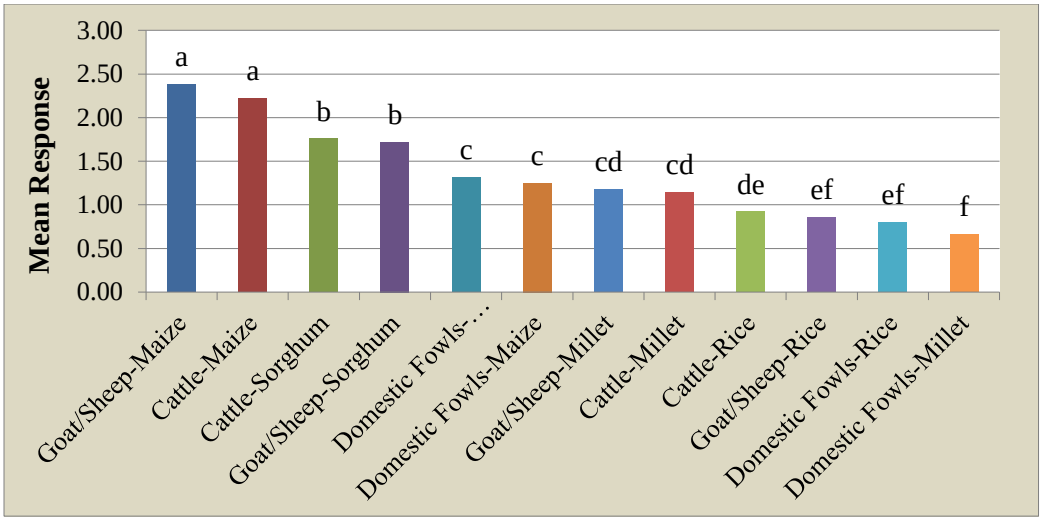

Fig. 9 Farmers' rating of impact of each livestock on each cereal crop (interaction of livestock type and crop type)

Source: Survey data analysis, 2015

3.1.7: Impact of interaction of location, livestock type and crop type on cereals production

Table 1 contains the result of interactions of location, livestock type and crop type (location∗livestock type∗crop type). Here, the impact of the three factors is jointly assessed hence it shows how the farmers rated the impact of each livestock on each cereal crop in each location. The question is: in each location sampled, how did each livestock type affect each crop? It tests the hypothesis which states that there is no locational difference in the impact of each grazing livestock on each crop. The result, $F(24, 2574) = 16.22$, $p = .00$, showed that there were significant ($P < .01$) interaction effects of location, livestock type and crop type hence, the null hypothesis was rejected. This implies that at the locational level, there were significant ($p < .01$) differences in the impact of some livestock on some crops. The interaction of location, crop type and livestock type is represented in Fig. 10 but for a better understanding of implications of the interaction, mean separation for each Area Council was done separately and presented in Figs 11 - 15.

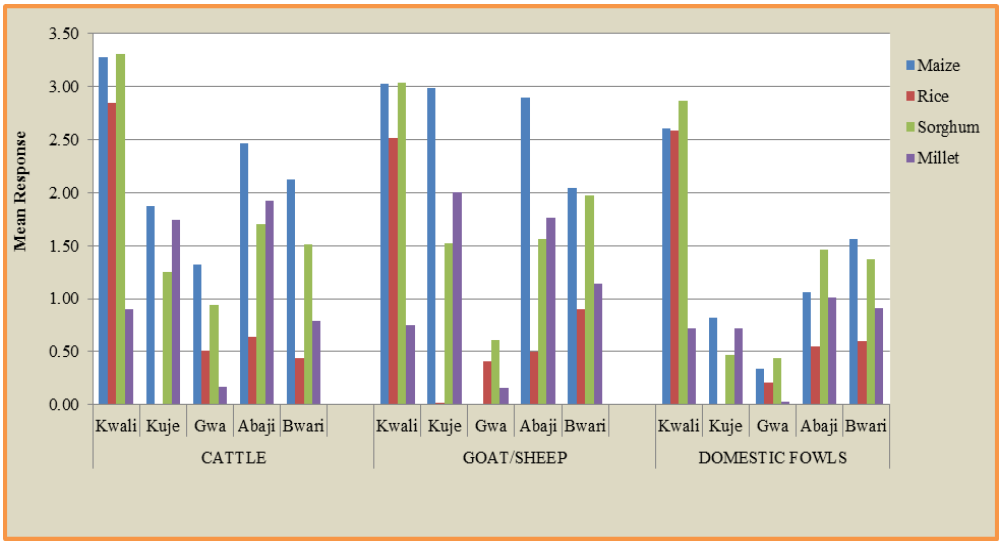

Fig. 10: Farmers' rating of impact of each livestock on each cereal crop in each location (interaction of location, livestock type and crop type)
Source: Survey data analysis, 2015

3.1.8: Impact of grazing livestock on cereal crops production in Kwali Area Council

The result of mean separation of the interaction of location, livestock type and crop type for Kwali Area Council is presented in Fig 11. It is worthy to note that the farmers rated the impact of cattle on sorghum, maize and rice very high. The mean responses showed that the impact of cattle on sorghum and maize was not significantly ($P > 0.05$) different from each other implying that sorghum and maize were highly vulnerable to destruction by cattle compared to other crops. This is discouraging and may have contributed to the low productivity of these crops in Nigeria compared to India according to Ahmad, Samuel, Makama, and Kiresur (2015). On the other hand, sorghum and maize were also rated as being vulnerable to destruction by domestic fowls.

Based on the mean response, rice was also affected by cattle, goat/sheep and domestic fowls but the impact was not as high as that of sorghum and maize. The least affected crop in the area was millet. This means that among the four cereal crops studied, millet was one of the crops that could be produced with minimal destruction by grazing livestock. The destruction of crops by grazing livestock is contrary to the concept of sustainable agricultural development and has to be addressed so that it does not add to the numerous challenges hindering farmers' productivity as outlined by Ohen and Ajah (2015) and Ismaila, Ghana, Tswanya and Dogara (2010). Comparing this result to the one in Fig. 7 which showed that maize was the most affected crop while rice was the least affected, it can be seen that sorghum was the most affected crop while millet was the least affected crop in Kwali Area Council. If policies were to be made based on the result in Fig. 7, emphasis would have been placed generally on rice as the least affected crop hence the importance of interaction of location, crop type and livestock type in the analysis.

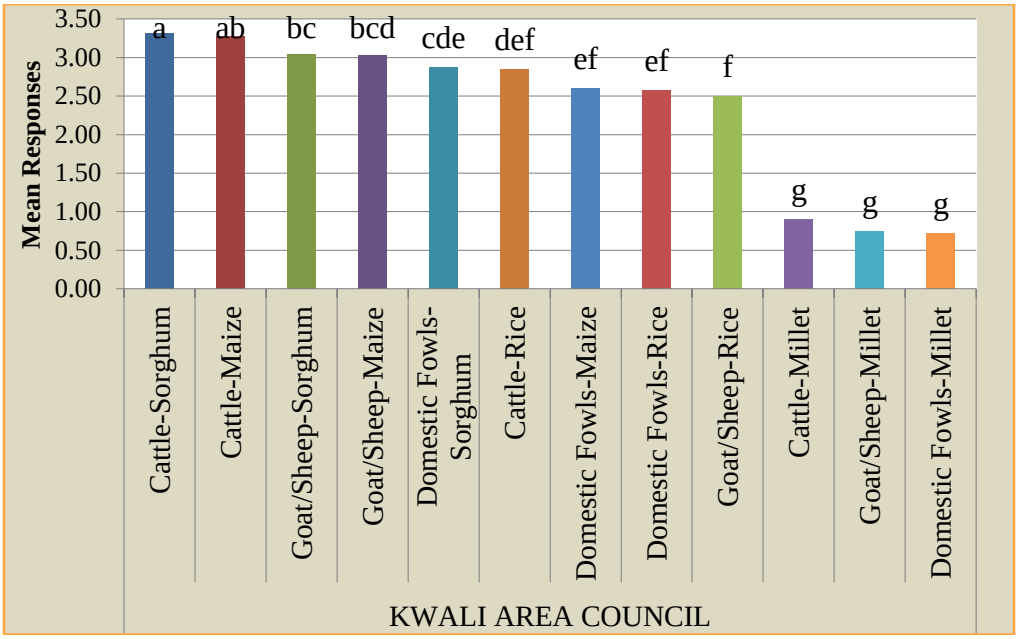

Fig. 11: Farmers' rating of impact of each livestock on each cereal crop in Kwali Area Council (extracted from fig 10)

Source: Survey data analysis, 2015

3.1.9: Impact of grazing livestock on cereal crop production in Kuje Area Council

The result of mean separation of interaction of location, livestock type and crop type for Kuje Area Council is presented in Fig 12. The mean responses showed that the farmers rated maize as most vulnerable to destruction by goat/sheep. The impact of goat/sheep on maize was significantly ($p < .05$) higher than the impact of cattle and domestic fowls on maize and other cereal crops studied. The second most affected crop was millet and this is contrary to the result in Fig 8 where sorghum was second to maize with rice being the least. This further highlights the importance of using three-way mixed analysis of variance in the study. It provided the true picture of the

impact of livestock on cereal crops production in different locations thereby opening the window for different policy options. Generally, while maize and millet were the most affected crops, rice was the least. The impact of domestic fowls was the least compared to those of cattle, goat/sheep. Based on the result, it can be inferred that rice is one of the crops that could be produced in Kuje Area Council with minimal destruction by grazing livestock.

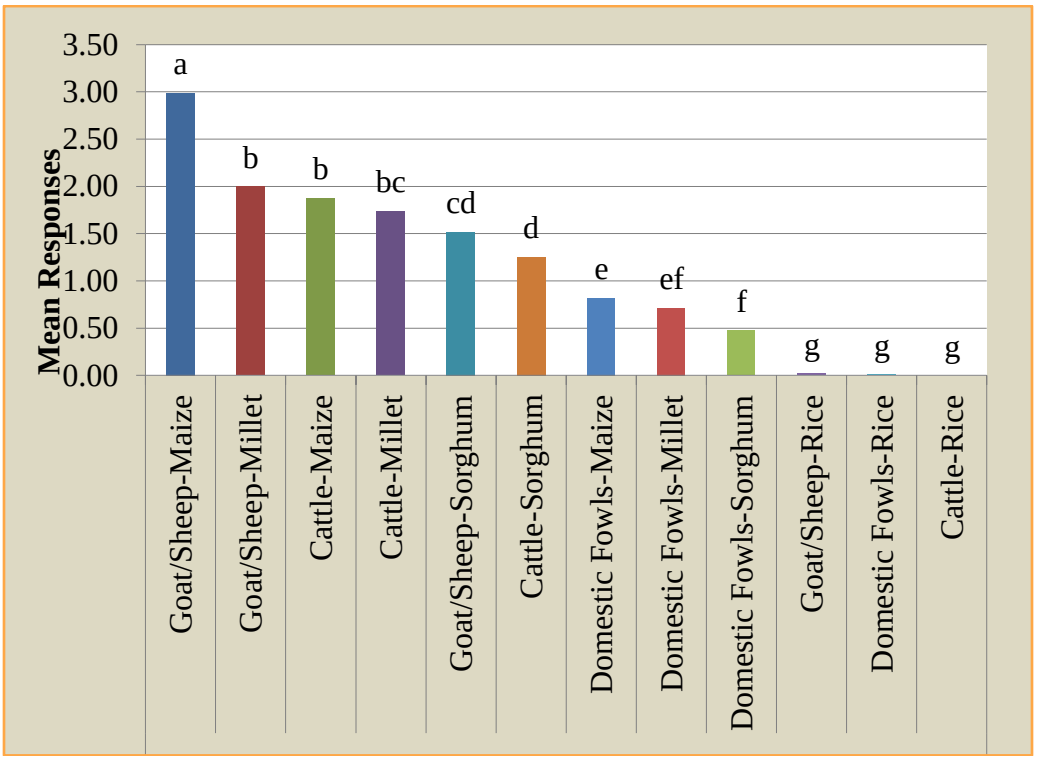

Fig. 12: Farmers' rating of impact of each livestock on each cereal crop in Kuje Area Council (extracted from fig 10)

Source: Survey data analysis, 2015

3.1.10: Impact of grazing livestock on cereals production in Gwagwalada Area Council

The result of mean separation of the interaction of location, livestock type and crop type for Gwagwalada Area Council is shown in Fig. 13. The result showed that maize was the most vulnerable to destruction by grazing cattle. The mean responses indicated that the impact of grazing cattle on maize was significantly ($p < .05$) higher than the impact of goat/sheep and domestic fowls on other crops. Similarly, the farmers' rating indicated that the impact of grazing cattle on sorghum was also high although it did not significantly differ from the impact of goat/sheep on maize. Judging from the mean responses, millet was the least affected crop implying that it is one of the crops that can be produced in this location with minimal destruction by grazing livestock. It is worthy to note here that even though there were significant differences in the mean responses, the mean ratings for the impact of grazing livestock on cereal crops production were generally low compared to other locations. This calls for further investigation to find out if, they have grazing routes and are adhering to them. Further inquiry should be made to know if they have bye-laws or customary laws that regulate the behaviour of crop and livestock farmers resulting in minimal interaction between livestock and crops on the farms.

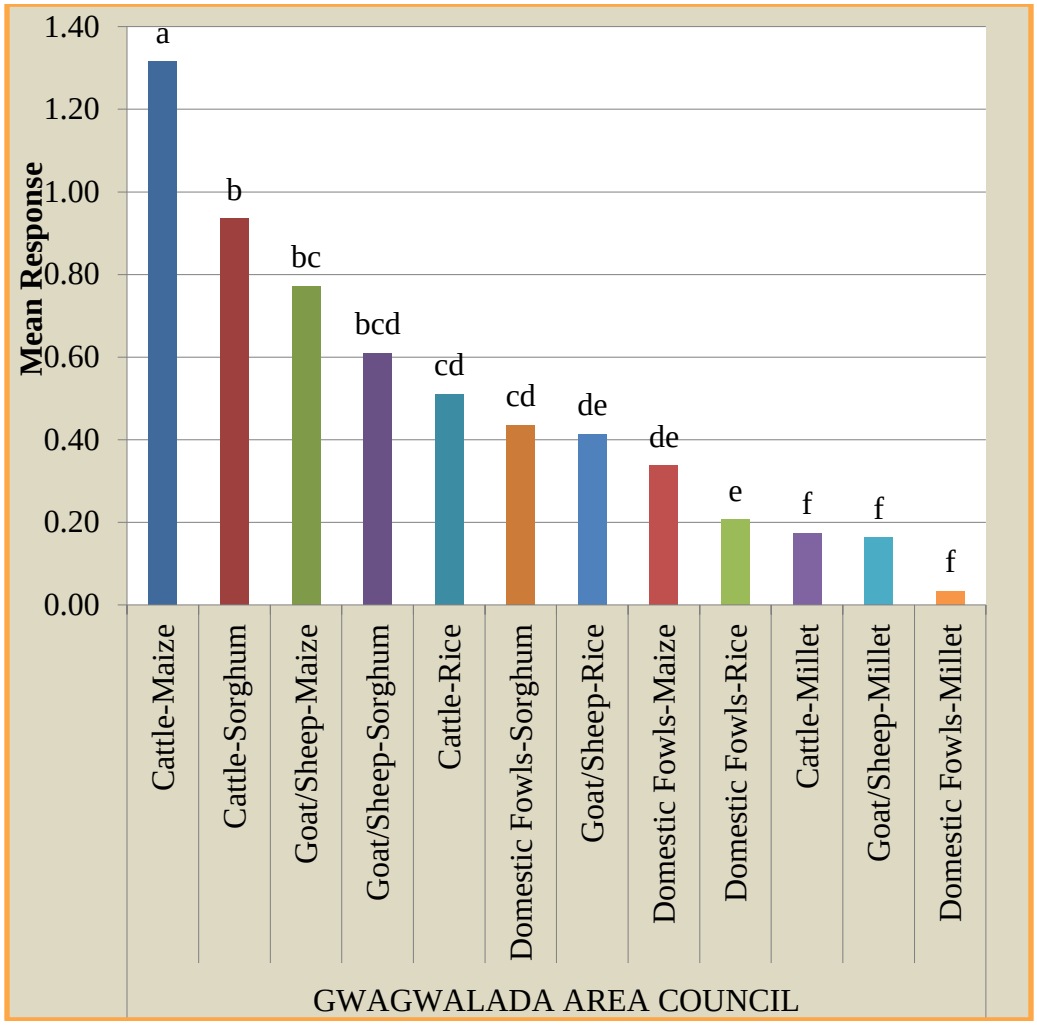

Fig. 13: Farmers' rating of impact of each livestock on each cereal crop in Gwagwalada Area Council (extracted from fig 10)

Source: Survey data analysis, 2015

3.1.11: Impact of grazing livestock on cereal crops production in Abaji Area Council

Like other Area Councils, the result of mean separation of the interaction of location, livestock type and crop type for Abaji Area Council is presented in

Fig. 14. The result showed that maize was the most vulnerable to destruction by grazing goat/sheep. The mean responses indicated that the impact of goat/sheep on maize was significantly ($p < .05$) higher than the impact of other animals on maize and other crops. Similarly, the impact of cattle on maize was significantly ($p < .05$) higher than the impact of domestic fowls. The famers rated the impact of cattle and goat/sheep on millet the same. Looking at the mean responses, it is evident that rice was the least affected crop. This result is similar to the one obtained in Kuje Area Council (Fig.12) and it could be that these Area Councils cultivated rice in *fadama* (water-logged) areas that are very difficult for the grazing livestock to access. It could also mean that rice is not a major crop cultivated in these area councils. Generally, it is clear that cattle, goat/sheep were the most destructive animals and their impact on crops has been noted as a major source of conflict between pastoralists and crop farmers in Nigeria (Blench, 2010).

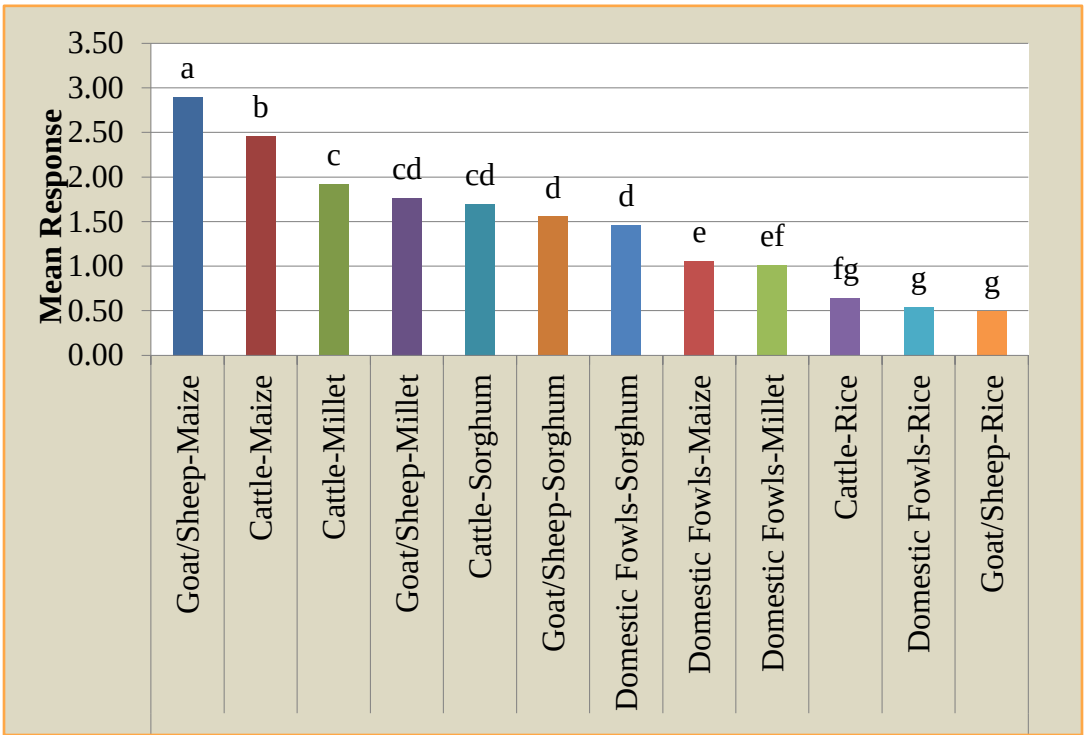

Fig. 14: Farmers' rating of impact of each livestock on each cereal crop in Abaji Area Council (extracted from fig 11)

Source: Survey data analysis, 2015

3.1.12: Impact of grazing livestock on cereal crops production in Bwari Area Council

The result in Fig.15 is the mean separation of interaction of location, livestock type and crop type for Bwari Area Council. The result indicated that the most affected crop was maize followed by sorghum. The impact of cattle on maize was not significantly ($p > .05$) different from that of goat/sheep. Although the mean responses were not the same, it shows that cattle and goat/sheep were the most destructive livestock. The rating of impact of domestic fowls on maize was also relatively high compared to

other crops. Like other area councils, farmers in this location rated the impact of grazing livestock on rice and millet very low. In other words, among the cereal crops, millet and rice were some of the crops that could be produced in Bwari Area Council with minimal destruction by grazing livestock.

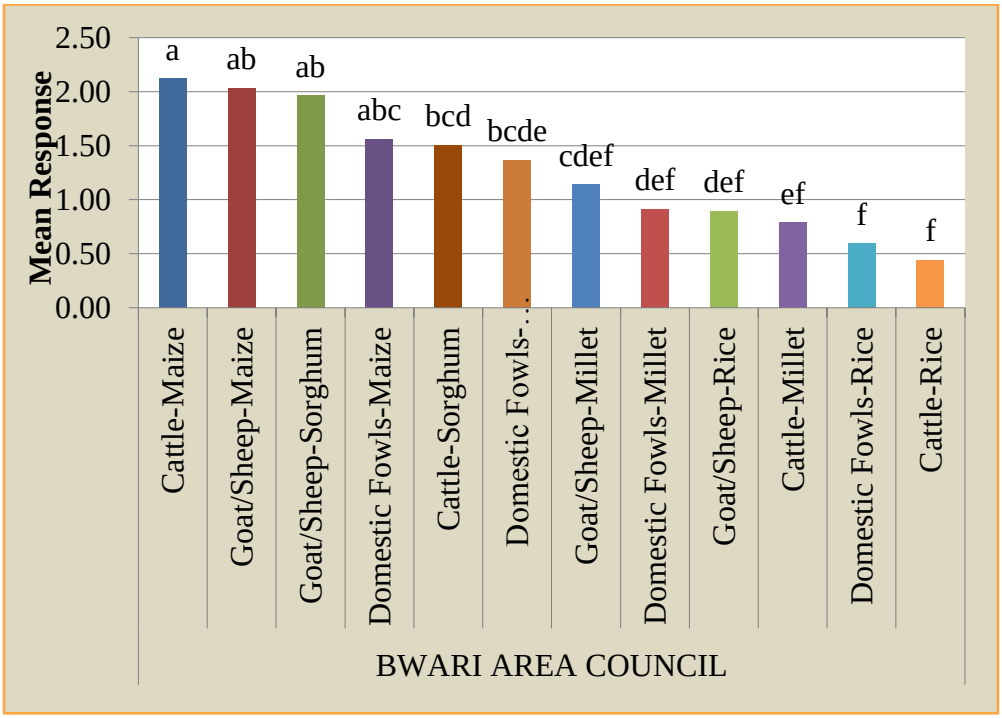

Fig. 15: Farmers' rating of impact of each livestock on each cereal crop in Bwari Area Council (extracted from fig 10)
Source: Survey data analysis, 2015

3.2.0: Analysis of the impact of grazing livestock on tuber crops production

Table 2 shows the three-way mixed analysis of variance (ANOVA) results of the impact of grazing livestock on tuber crops (yam, cassava, potato) production. Like cereal crops, the model gives the opportunity to look at the

data in different ways and take appropriate decisions. For a better understanding of the results, the interpretation is based on the three factors and their interactions.

Table 2 ANOVA results of the impact of grazing livestock on tuber crops production

Sources of variation	df	SS	MS	F-cal	P-value
Livestock type	2	605.35	302.67	521.06	0.00
Location∗livestock type	8	241.15	30.14	51.96	0.00
Error (livestock type)	830	483.06	0.58		
Crop type	2	84.39	42.19	131.31	0.00
Location∗crop type	8	16.25	2.03	6.34	0.00
Error (crop type)	830	268.19	0.32		
Crop type∗livestock type	4	46.73	11.68	40.24	0.00
Location∗livestock type∗crop type	16	56.67	3.54	12.20	0.00
Error (Crop type∗livestock type)	1660	495.85	0.29		
Location	4	86.54	21.63	270.37	0.00
Error (location)	415	34.71	0.08		

Source: Survey data analysis, 2015

3.2.1: Impact of grazing livestock on tuber crops production in different locations

Table 2 shows the impact of grazing livestock on tuber crops production in different locations (main effect of location). It shows the differences in impact of grazing livestock on tuber crops (yam, cassava, potato) in different area councils. The question is: without reference to a particular livestock or tuber crop, how did farmers in different locations rated the impact of grazing livestock on the tuber crops? It tests the hypothesis which states that there is no significant locational difference in the impact of grazing livestock on tuber crops production ($\mu_{Kwali} = \mu_{Kuje} = \mu_{Gwagwalada} = \mu_{Abaji} = \mu_{Bwari}$). The result, $F(4, 415) = 270.37$, $p = .00$, shows that there were locational differences in impact of grazing livestock on tuber crops production, hence the rejection of the null hypothesis. Furthermore, mean separation was carried out and the results (Fig. 16) show that the impact of grazing livestock on tuber crops production was felt more by farmers in Kuje and Abaji Area Councils. The impact of grazing livestock in Kuje and Abaji Area Councils was statistically the same ($p > .05$) but significantly higher than that of Kwali Area Council which in turn, was significantly higher ($p < .05$) than that of Bwari Area Council. Similarly, the impact of grazing livestock in Bwari Area Council was significantly ($p < .05$) greater than that of Gwagwalada Area Council. Although, there were significant locational differences, the magnitude of the mean responses conveyed an important message. It shows that the farmers rated the impact of grazing livestock on tubers very low especially in Kwali, Bwari and Gwagwalada Area Councils. The policy implication of the magnitude of the mean responses is that grazing livestock did not constitute a major threat to tuber crops production in these locations. But using this result to take decision may be misleading hence, the need to

look at the interaction results of factors which are presented in subsequent analyses.

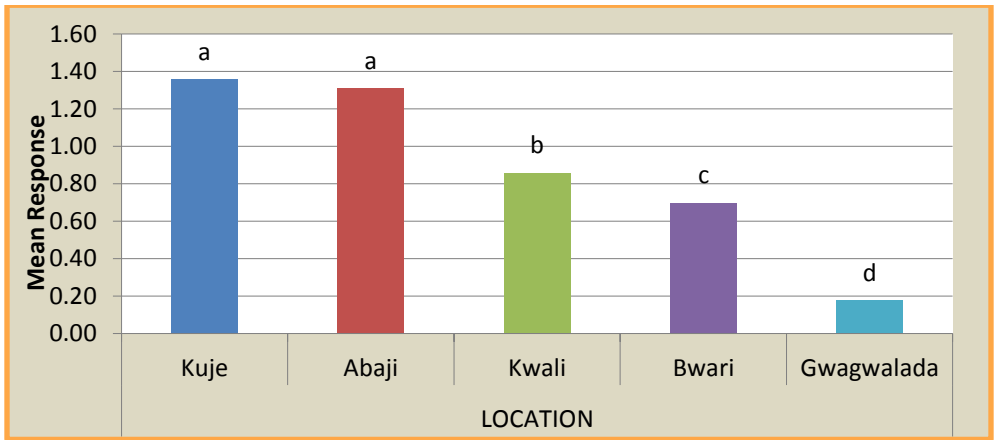

Fig. 16: Farmers' rating of impact of livestock on tuber crops production in each location
Source: Survey data analysis, 2015

3.2.2: Impact of grazing livestock on tuber crops production due to livestock type

The impact of grazing livestock on tuber crops production due to livestock type (main effect of livestock type) is shown on Table 2. Here, emphasis is laid on the most destructive livestock regardless of whether it is yam, cassava or potato. The question is: without reference to any particular location or crop type, does the impact of cattle, goat/sheep and domestic fowls on tuber crop differ from each other? It tests the hypothesis which states that the impact of grazing livestock on tuber crops production does not depend on the type of livestock reared ($\mu_{Cattle} = \mu_{Goat/Sheep} = \mu_{Domestic\ Fowls}$). The result, $F(2, 830) = 521.06$, $p = .00$, indicated that there was significant ($p < .01$) difference in the impact of cattle, goat/sheep and domestic fowls on tuber crops production, hence the rejection of the null hypothesis.

This means that the impact of livestock on tuber crops production depends on whether it is cattle, goat/sheep or domestic fowls (livestock type) that are grazing. Mean separation (Fig. 17) was done and it shows how the farmers rated the impact of each animal on tuber crops in the area. Among the three livestock types, cattle were perceived or rated as the most destructive compared to goat/sheep and domestic fowls. The mean responses showed that the impact of cattle on tuber crops production was significantly ($p < .05$) higher than the impact of goat/sheep while that of goat/sheep was significantly higher ($p < .05$) than that of domestic fowls. Based on magnitude of the mean response, cattle and goat/sheep were the most destructive while domestic fowls were the least. The mean response connotes that the impact of domestic fowls was not a major factor limiting the production of tuber crops in the study area. Although the impact of domestic fowls on crops (in the field) was rated low, it is important to highlight that domestic fowls also feed on harvested crops during sun drying[2], which further reduces total output.

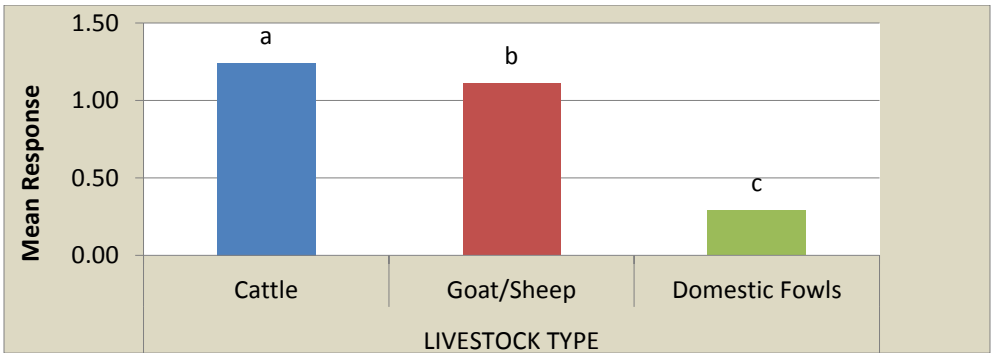

Fig. 17: Farmers' rating of impact of each livestock on tuber crops production (main effect of livestock type)

[2] A major process of moisture reduction for cereal crops in rural communities.

Source: Survey data analysis, 2015

3.2.3: Impact of interaction between location and livestock type on tuber crops production

The result of interaction between location and livestock type (location∗livestock type) is shown in Table 2. The question is: in each area council sampled, how did the farmers perceived or rated the impact of each livestock on tuber crops production? Answering this question led to the test of hypothesis which states that there is no significant interaction between location and livestock type. The result, $F(8, 830) = 51.96$, $p = .00$, shows that there was significant ($p < .01$) interaction between location and livestock type, hence the rejection of the null hypothesis. This implies that the impact of cattle, goat/sheep and domestic fowls on tuber crops production was not the same in some of the area councils. The mean separation (Fig. 18) shows how farmers rated the impact of each livestock on the tuber crops in each location. The result indicated that in Kwali and Bwari Area Councils, cattle was rated as the most destructive and its impact on tuber crops was significantly ($p < .05$) higher than that of goat/sheep, while that of goat/sheep was significantly ($p < .05$) higher than that of domestic fowls. On the contrary, in Kuje Area Council, goat/sheep was rated as the most destructive followed by cattle. The mean response indicated that the impact of goat/sheep was significantly ($p < .05$) higher than that of cattle while that of cattle was significantly higher than that of domestic fowls.

In Abaji Area Council, the farmers rated the impact of cattle and goat/sheep on tuber crops production the same but their impact was significantly ($p < .05$) higher than that of domestic fowls. The scenario in Gwagwalada Area

Council was different. Although the rating of impact of livestock on tuber crops was not the same in Gwagwalada, the magnitude of mean response was generally very low. This is why the analysis of interaction between factors is very important. If we had used the result in Fig. 18 to take decision, we would have assumed that all the area councils faced similar challenges in the production of tuber crops but it can be seen that the impact on the tuber crops varied from one location to another.

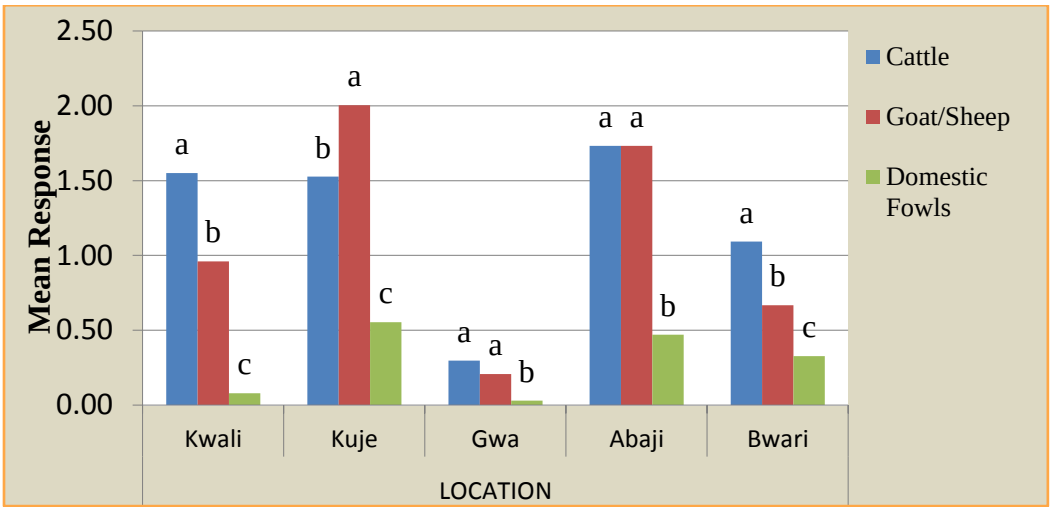

Fig. 18: Farmers' rating of impact of each livestock on tuber crops production in each location (interaction of location and livestock type)
Source: Survey data analysis, 2015

3.2.4: Impact of grazing livestock on tuber crops production due to crop type

The result of the main effect of crop type is shown in Table 2. Here, emphasis is placed on the most affected tuber crop regardless of whether it is done by cattle, goat/sheep or domestic fowls. The question is: in the entire study area, does the impact of grazing livestock depend on type of tuber crop

cultivated? It tests the hypothesis which states that the impact of grazing livestock on tuber crops production does not depend on type of crop cultivated ($\mu_{Yam} = \mu_{Cassava} = \mu_{Potato}$). The result, $F(2, 830) = 131.31$, $p = .00$, indicates that the main effect of crop type was significant ($p < .01$), hence the rejection of null hypothesis. This shows that the impact of grazing livestock on tuber crops depends on crop type. In other words, some tuber crops were more vulnerable to destruction by grazing livestock than others. To identify which tuber crop was more vulnerable to destruction, mean separation (Fig. 19) was done and it showed that cassava was the most affected tuber crop. This implies that the livestock preferred cassava to other tuber crops. The impact of grazing livestock on cassava was significantly ($p < .05$) higher than that on yam, while that on yam was significantly higher ($p < .05$) than that on potato. This shows that the nature of a crop is an important factor in studying the impact of grazing livestock on crop production. The fact that cassava was the most affected tuber crop calls for attention because cassava is important both as a food crop as well as a source of raw material for many industries (Balami, Ogboru and Talba, 2011). It also serves as feed for farm animals.

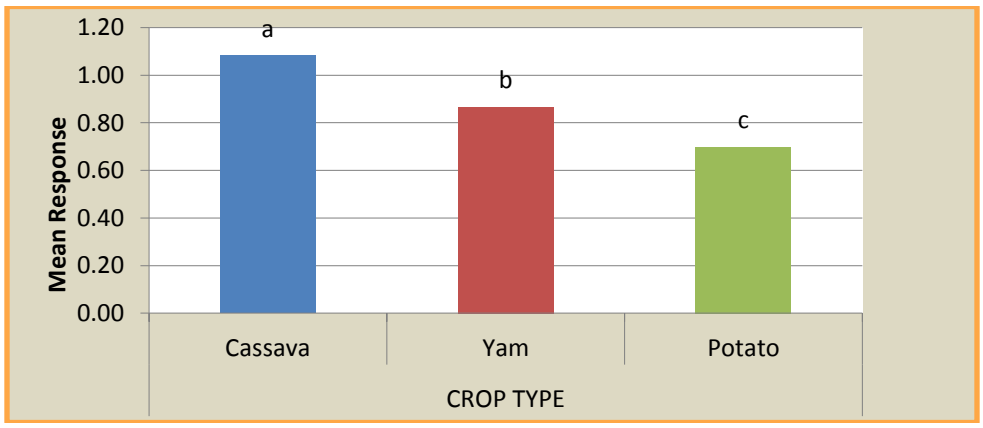

Fig. 19: Farmers' rating of impact of livestock on each tube crop (main effect of crop type)

Source: Survey data analysis, 2015

3.2.5: Impact of interaction between location and crop type on tuber crops production

The result of interaction between location and crop type (location∗crop type) is shown in Table 2. In this interaction, emphasis is on the most affected tuber crop in each location regardless of whether the impact is from cattle, goat/sheep or domestic fowls hence the question is: does the impact of grazing livestock on each tuber crop differ in each location and which tuber crop was mostly affected (destroyed)? It tests the hypothesis which states that there is no significant interaction between location and crop type. The result, $F(8, 830) = 6.34$, $p = .00$, showed that there was significant interaction between location and crop type.

This implies that in some area councils, some tuber crops were more vulnerable to destruction than others, hence the rejection of the null hypothesis. Mean separation (Fig. 20) shows that, apart from Bwari Area Council, cassava was the most affected tuber crop in four locations. The impact of grazing livestock on cassava in the four locations was significantly ($p < .05$) higher than the impact on yam and potato. In Bwari Area Council, the impact on cassava and yam was rated the same. In Kwali, Kuje, Gwagwalada and Bwari Area Councils, the impact of livestock on yam was significantly ($p <.05$) higher than that of potato, but in Abaji, there was no difference ($p >.05$). Generally, the mean responses indicated that the farmers rated cassava as the most affected tuber crop while the least was potato.

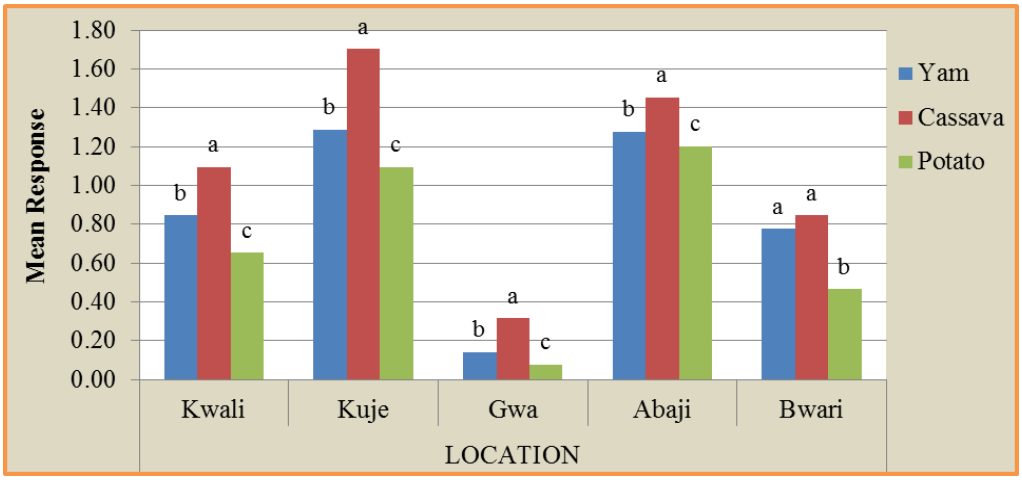

Fig. 20: Farmers' rating showing most affected tuber crop by grazing livestock in each location (interaction of location and crop type)
Source: Survey data analysis, 2015

3.2.6: Impact of interaction between livestock and crop type on tuber crops production

Table 2 contains the result of the interaction between crop type and livestock type (crop type∗livestock type). It shows how the farmers rated the impact of cattle, goat/sheep and domestic fowls on each tuber crop in the whole study area. It is not location specific, but focuses on how each livestock affected each tuber crop in general. In other words, how did the farmers perceived the impact of each livestock type on each tuber crop? The hypothesis states that there is no significant interaction between crop type and livestock type. The result, $F(4, 1660) = 40.24$, $p = .00$, showed that there was significant interaction between crop type and livestock type, thus the rejection of the null hypothesis. This implies that particular livestock were associated with greater destruction of some tuber crops. Mean separation (Fig. 21) indicated

that cassava and yam were more vulnerable to destruction by grazing cattle compared to other crops. In other words, cassava and yam were mostly affected by grazing cattle. The impact of cattle on cassava and yam was not significantly ($p > .05$) different from each other but significantly greater than the impact of goat/sheep and domestic fowls on other tuber crops. The mean responses also showed that there was no significant difference ($p > .05$) in the impact of domestic fowls on the three tuber crops. Again, the magnitude of the mean responses showed that domestic fowls had the least impact on the tuber crops. Therefore, it can be inferred that domestic fowls reared under extensive system were not major factors limiting the production of tuber crops in the area.

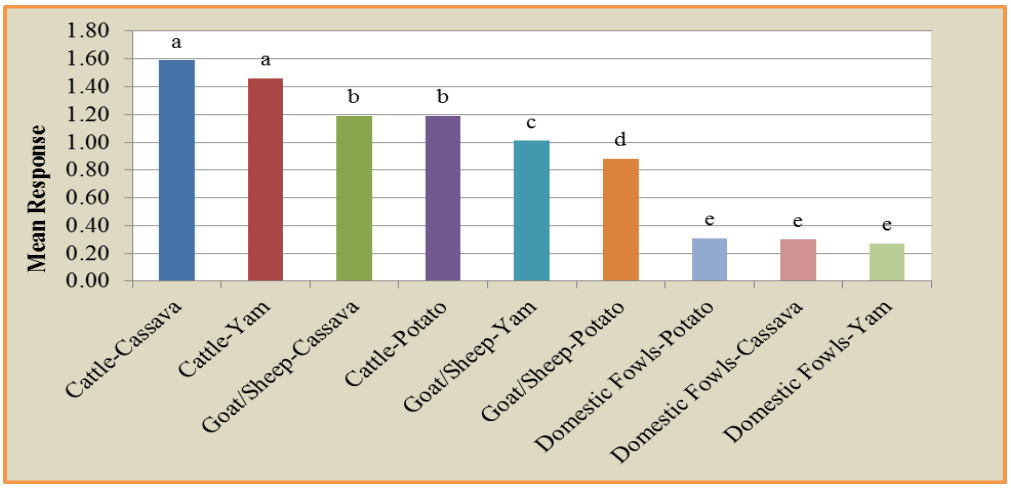

Fig. 21: Farmers' rating of impact of each livestock on each tuber crop (interaction of livestock type and crop type)

Source: Survey data analysis, 2015

3.2.7: Impact of interaction of location, livestock type and crop type on tuber crops

The result of interaction of location, livestock type and crop type (location∗livestock∗type crop type) is shown in Table 2. This is one of the most important results because it shows how the farmers rated the impact of each livestock on each tuber crop in each location. The question is: does the impact of each livestock type on each tuber crop differ in each location? It tests the hypothesis which states that there is no significant interaction effect of location, livestock type and crop type. The result $F(16, 1660) = 12.20$, $p = .00$, showed that there was significant ($p < .01$) interaction of location, livestock type and crop type, hence the null hypothesis was rejected. The result of the interaction is shown in Fig. 22 but for a better understanding of the implications of the interaction, mean separation was done for each area council and reflected in Figs. 23 - 27.

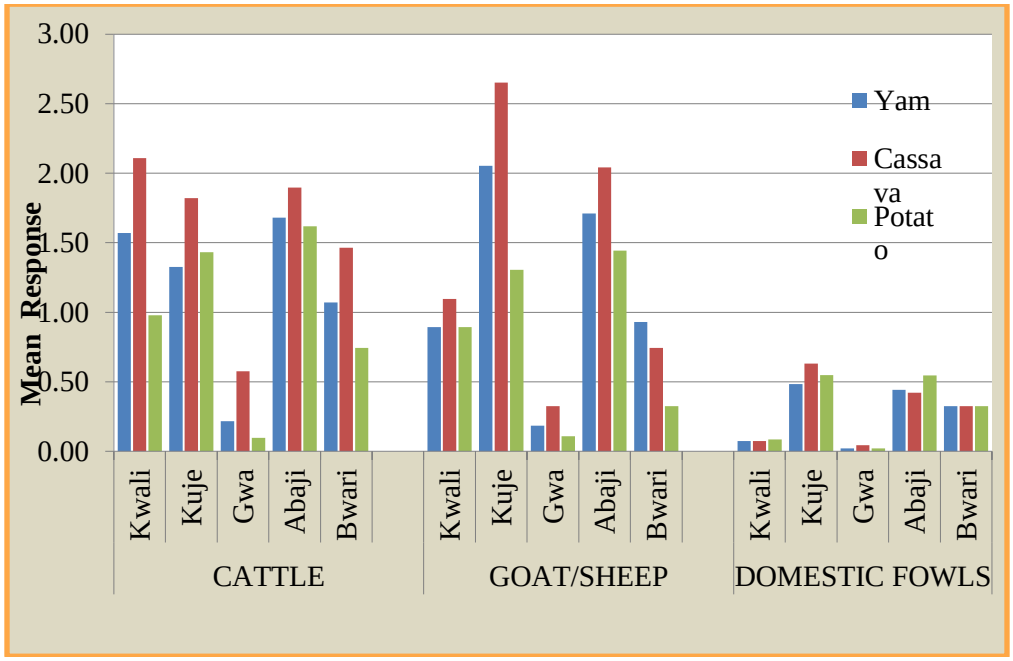

Fig. 22: Farmers' rating of impact of each livestock on each tuber crop in each location (Interaction of location, livestock type and crop type)
Source: Survey data analysis

3.2.8: Impact of grazing livestock on tuber crops production in Kwali Area Council

The result of mean separation of the interaction of location, livestock type and crop type for Kwali Area Council is shown in Fig. 23. It shows how the farmers rated the impact of each livestock type on each tuber crop in the area. The results indicate that the impact of cattle on cassava was significantly ($p < .05$) higher than the impact of goat/sheep and domestic fowls. Looking at the mean responses, yam was next to cassava and it is mostly destroyed by cattle. Similarly, the impact of goat/sheep was significantly ($p < .05$) higher than that of domestic fowls. Considering the magnitude of the mean responses, it can be seen that the farmers rated the impact of cattle on cassava and yam high while that of goat/sheep was the

least. The impact of domestic fowls on the tuber crops approximates to no impact. In this regard, it can be inferred that rearing domestic fowls under extensive system does not constitute a major threat to the production of cassava, yam and potato in Kwali Area Council, however, cattle and goat/sheep negatively affect the production of the tuber crops to a reasonable extent.

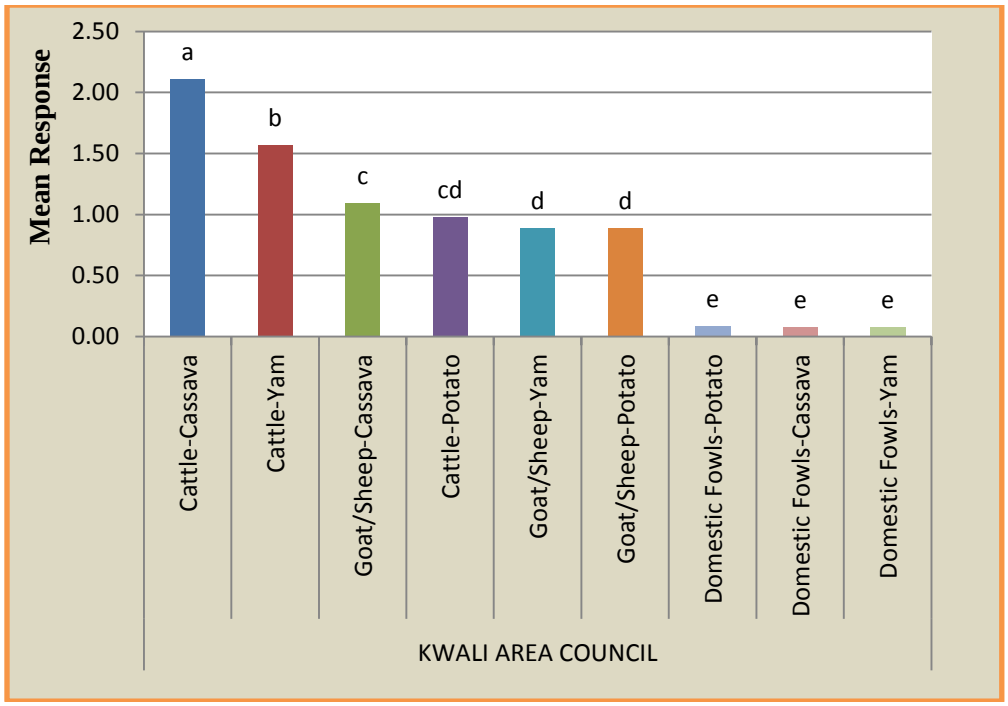

Fig. 23: Farmers' rating of impact of each livestock on each tuber crop in Kwali Area Council (extracted from fig. 22)

Source: Survey data analysis, 2015

3.2.9: Impact of grazing livestock on tuber crops production in Kuje Area Council

The result of mean separation of interaction of location, livestock type and crop type for Kuje Area Council is shown in Fig. 24. The mean responses

showed that cassava was most vulnerable to destruction by grazing goat/sheep and not cattle as in Kwali Area Council (Fig. 23). The impact of goat/sheep on cassava was significantly ($p < .05$) greater than that of cattle and domestic fowls. The second most affected tuber crop was yam; this was also associated with goat/sheep. The impact of cattle on cassava comes third and it is not significantly ($p > .05$) higher than that of goat/sheep on yam. The mean responses also indicated that there was no significant difference ($p > .05$) in the impact of domestic fowls on cassava, yam and potato. Generally, it is evident that cattle and goat/sheep had the highest impact on the tuber crops while domestic fowls, had the least. Thus, it can be inferred that rearing domestic fowls under extensive system does not pose much threat to the production of cassava, yam and potato in Kuje Area Council, however, cattle and goat/sheep negatively impact the production of the tuber crops to a reasonable extent.

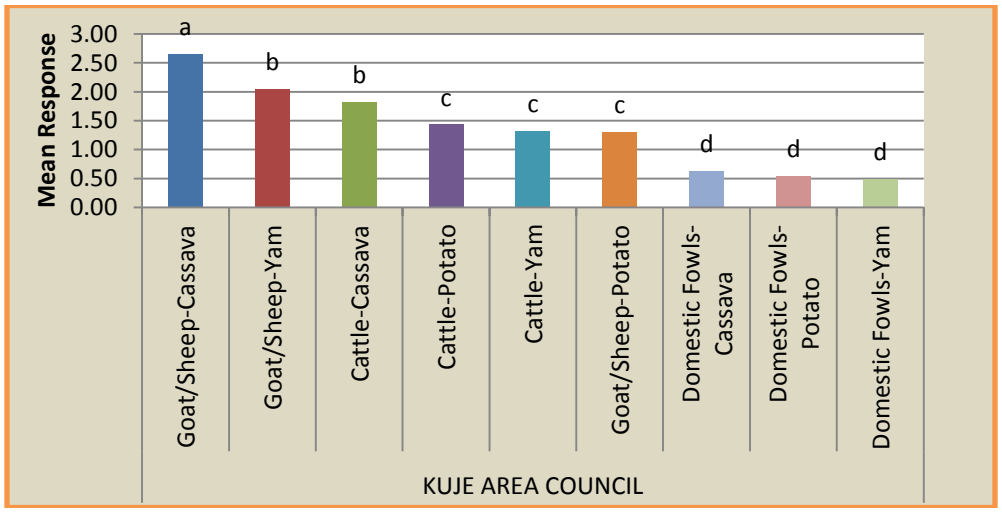

Fig. 24: Farmers' rating of impact of each livestock on each cereal crop in Kuje Area Council (extracted from fig. 22)

Source: Survey data analysis, 2015

3.2.10: Impact of grazing livestock on tuber crops production in Gwagwalada Area Council

The result of mean separation of interaction of location, livestock type and crop type for Gwagwalada Area Council is shown in Fig. 25. The mean responses indicated that cassava was the most affected tuber crop by cattle and goat/sheep. The impact of cattle on cassava was significantly ($p < .05$) higher than that of goat/sheep and domestic fowls on yam and potato. Generally, the magnitude of the mean responses showed that farmers rated the impact of livestock on tuber crops production very low especially domestic fowls. This is similar to the result obtained for cereal crop production in the same area (see Fig. 13). Based on the mean rating for each livestock type, it can be inferred that grazing livestock are not major factors limiting the production of cassava, yam and potato in Gwagwalada Area Council. In other words, farmers in this location did not see grazing livestock as a major threat to the production of the tuber crops. This result calls for further investigation to determine why the rating of the impact of grazing livestock on tuber crops production was very low. Is it because the farmers are not into tuber crops production? Is it because they have grazing routes and are adhering to them or do they have bye-laws guiding the behaviour of both livestock and crop farmers?

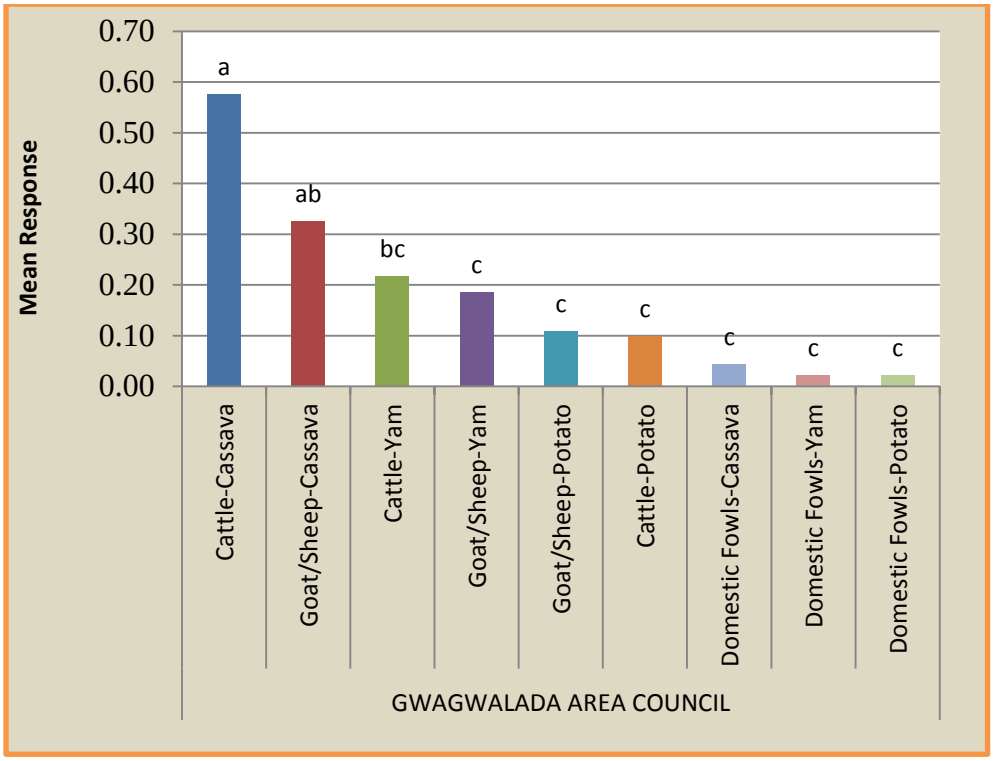

Fig. 25: Farmers' rating of impact of each livestock on each cereal crop in Kuje Area Council (extracted from fig. 22)

Source: Survey data analysis, 2015

3.2.11: Impact of grazing livestock on tuber crops production in Abaji Area Council

The result of mean separation of interaction of location, livestock and crop type for Abaji Area Council is shown in Fig. 26. The mean responses showed that cassava was the most affected tuber crop, with the damage being mostly from goat/sheep and cattle. The impact of goat/sheep and cattle on cassava was not significantly ($p > .05$) different from each other. The second most vulnerable to destruction was yam and the mean responses showed that the impact of goat/sheep and cattle on yam was not significantly ($p > .05$) different from each other. The impact of cattle and goat/sheep on cassava, yam and potato was significantly higher ($p < .05$) than that of domestic fowls but the impact of domestic fowls on the tuber crops was statistically the same ($p > .05$). Finally, it is evident that cattle and goat/sheep were rated as the

most destructive animals while domestic fowls had the least impact. In fact, the farmers' rating of the impact of domestic fowls on cassava, yam and potato approximates to no impact hence, it can be inferred that the rearing of domestic fowls under extensive system had very minimal impact on the production of the tuber crops in Abaji Area Council.On the contrary, goat/sheep and cattle affected the production of the tuber crops to a reasonable extent.

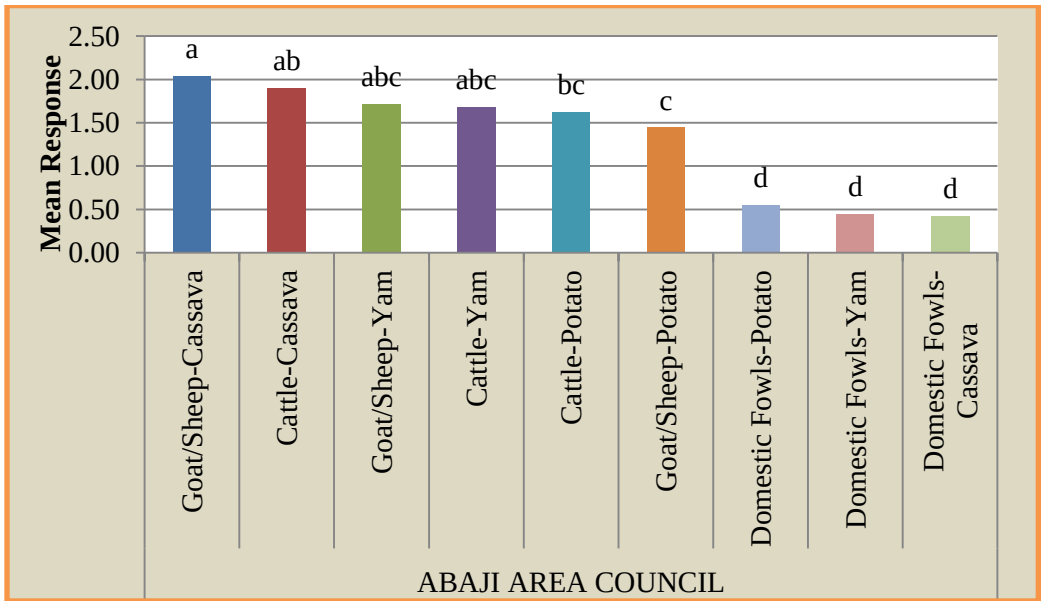

Fig. 26**:** Farmers' rating of impact of each livestock on each cereal crop in Abaji Area Council (extracted from fig 22)

Source: Survey data analysis, 2015

3.2.12: Impact of grazing livestock on tuber crops production in Bwari Area Council

The result of mean separation of interaction of location, livestock type and crop type for Bwari Area Council is shown in Fig. 27. Like other locations, the mean response indicated that cassava and yam were the most affected tuber crops and they were mostly damaged by grazing cattle. The impact of cattle on cassava and yam was not significantly different ($p > .05$) from each

other. This is followed by the impact of goat/sheep on yam, though the impact was not significantly different ($p > .05$) from that of cattle on cassava and yam. The mean responses on the impact of cattle and goat/sheep on cassava, yam and potato was significantly ($p < .05$) higher than that of domestic fowls suggesting that they were the most destructive livestock. The impact of domestic fowls on the tuber crops was statistically the same and approximates to no impact. Therefore, it can be deduced that domestic fowls reared under extensive system did not constitute major threat to the production of tuber crops in Bwari Area Council, while cattle and goat/sheep affected the production of the tuber crops to a reasonable extent.

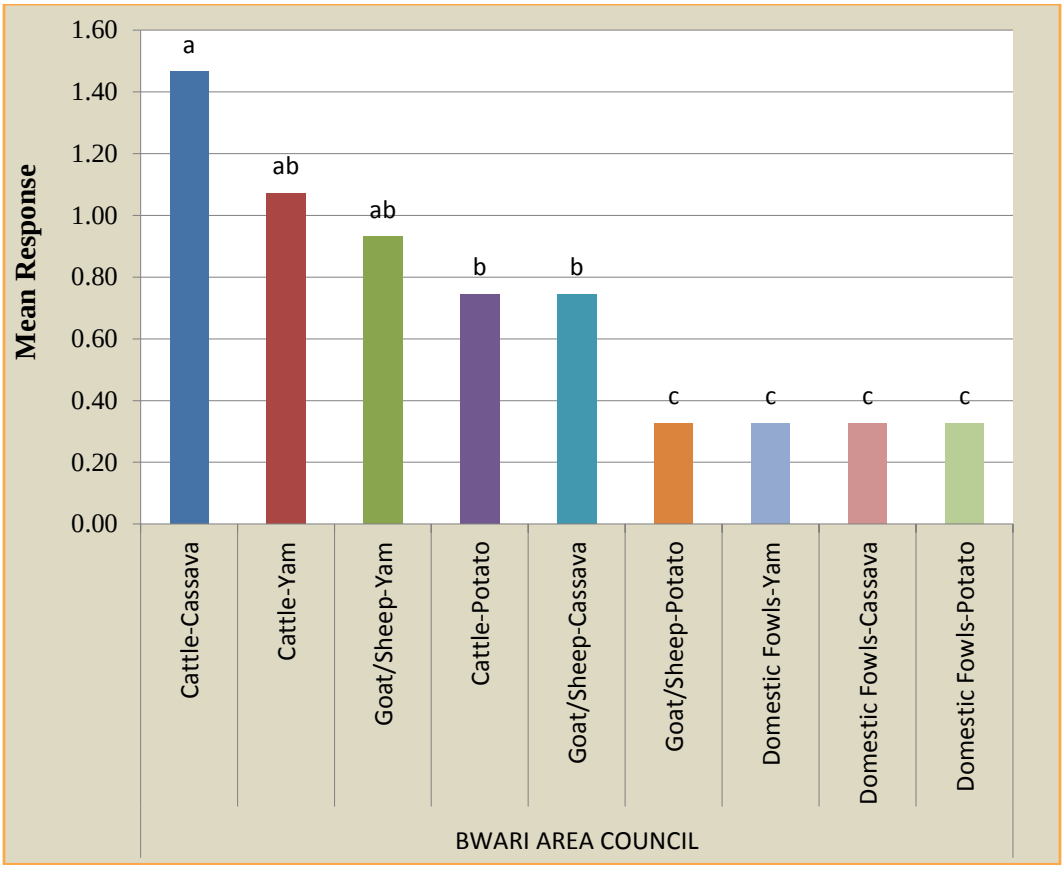

Fig. 27: Farmers' rating of impact of each livestock on each cereal crop in Bwari Area Council (extracted from fig. 22)

Source: Survey data analysis, 2015

3.3.0: Analysis of pooled data (combination of cereal and tuber crops data)

3.3.1: Impact of interaction between livestock type and crop type for pooled data

A comparative analysis of the impact of grazing livestock on both cereal and tuber crops was carried out. The result (Fig. 28) showed that among the cereal and tuber crops, maize was mostly affected by grazing livestock

followed by sorghum, cassava, yam, millet, potato and rice. The mean responses indicated that the first three crops were mostly affected by cattle and goat/sheep. The impact of domestic fowls on maize and sorghum was also prominent but not as that of cattle and goat/sheep. The mean responses indicated that cattle and goat/sheep were generally rated as the most destructive livestock to both cereal and tuber crops. The trend of impact also showed that among the seven crops, the impact of domestic fowls on yam was the least. Based on this analysis, it can be inferred that cereal crops like maize and sorghum were more vulnerable to destruction by grazing livestock compared to other cereal and tuber crops in the study area. Again, it can also be deduced from the analysis that apart from maize and sorghum, domestic fowls reared under extensive system, were not major limiting factors to the production of cereal and tuber crops in the study area.

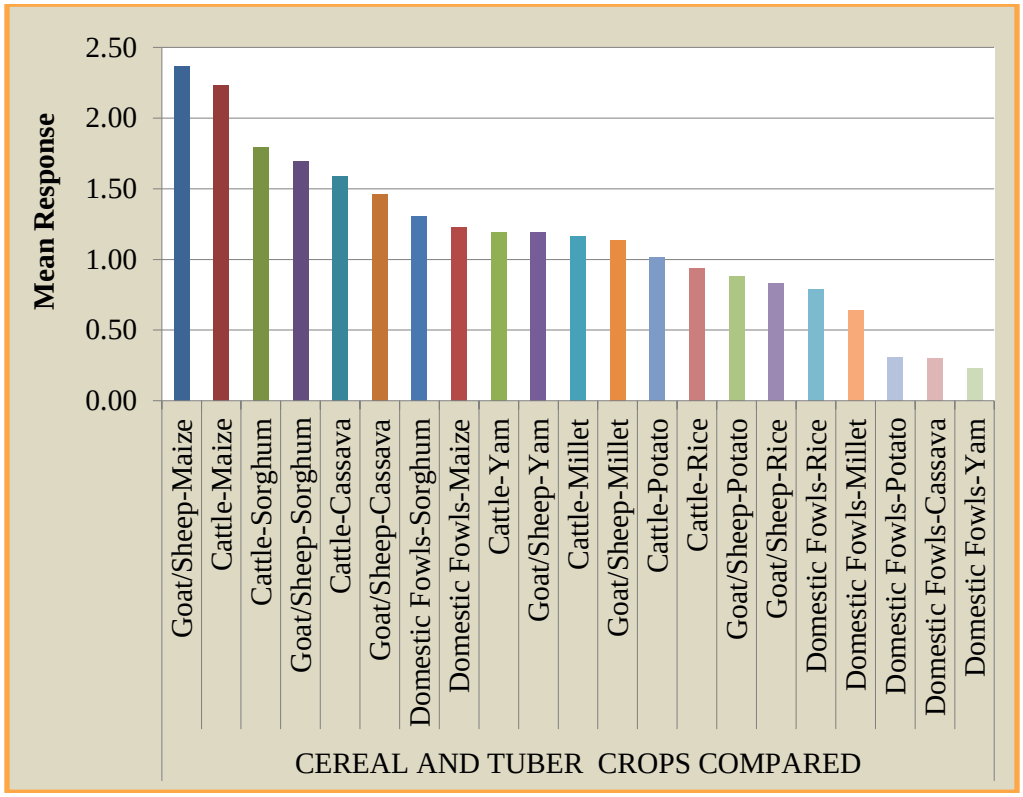

Fig. 28: Farmers' rating of impact of each livestock on each cereal and tuber crops
Source: Survey data analysis, 2015

3.3.2: Cost estimates of damaged cereal and tuber crops

During data collection, farmers were asked to estimate the cost of tuber and cereal crops damaged by grazing livestock on their farms. Only the farmers whose crops were damaged provided the cost estimate and the result is shown in Fig 29. First, looking at the cereal crops alone, it can be seen that the most affected crop was rice, followed by maize, sorghum and millet. This is contrary to the result in Fig. 8 where the mean responses indicated that the most affected crop was maize followed by sorghum and millet while the least affected was rice. The reason for rice coming first can be attributed

to the fact that the unit cost of rice is higher than that of maize and other cereal crops. Apart from this deviation arising from differences in market cost of rice, it is important to note that the order of rating of impact of grazing livestock on cereal crops tallied with the cost estimate of the damaged cereals. On the average, affected rice farmers lost ₦11,397 (US$ 71). This finding is discouraging as Nigeria is a major importer of rice (FAO, 2013a) which can actually be produced in the country. On the other hand, maize, sorghum and millet farmers lost ₦9,471 (US$ 59), ₦5,636 (US$ 35) and ₦4,532 (US$ 29) respectively to grazing livestock in 2014. Any small-scale farmer that suffers such loses due to grazing livestock is bound to be concerned. It is evident that the most affected tuber crop was cassava (₦11,745 ~ US$ 73) followed by yam (₦10,242 ~ US$ 64) and then potato (₦3,679 ~ US$ 23). This again, tallied with the mean response in Fig. 19 which showed that the farmers rated cassava as the most affected tuber crop followed by yam and potato. It should be noted that most of the damages on both cereal and tuber crops were caused by grazing cattle and goat/sheep although domestic fowls are not completely exempted from the damages.

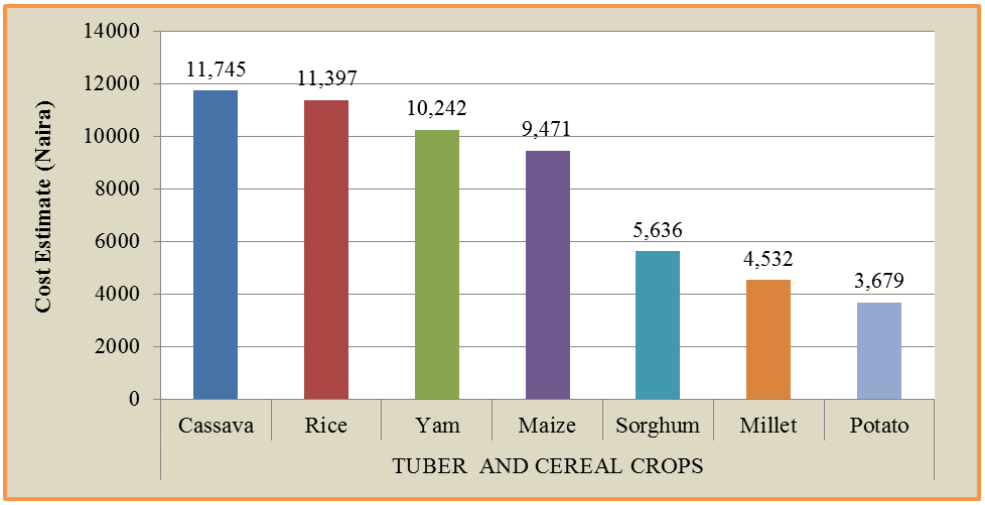

Fig. 29 Cost estimates[3] of cereal and tuber crops destroyed by grazing livestock

3.3.3: Socio-economic characteristics of the small-scale farmers

Information on some socio-economic characteristics of the farmers is shown in Table 3. The gender composition of the farmers sampled indicated only 22.35 percent were females while 77.65 were males. The skewness of the sample in favour of male farmers does not mean that there were few female farmers in the area but it reflects the challenges of accessing women in the northern part of Nigeria due to the restrictions of *purdah* - an Islamic practice that preaches minimal interaction of Muslim women with non-relatives especially men (Yusuf, 2014). Regardless of gender, most of the farmers (81.80%) were married with mean household size of 7 people. In terms of age, majority of them were adults with an average age of 46 years. The mean age suggests that most of the farmers were relatively young and able-bodied to carry out manual agricultural operations. A greater

[3] The average exchange rate as of November 2014 was ₦ 160 to US$1 (CBN, 2014).

proportion (61.02%) of the farmers had at least primary school education while 38.98% had no formal education. This is encouraging and a pointer to the fact that in future, Nigerian agriculture is likely to be dominated by those who are literate. The farmers had an average of 26 years farming experience with greater number (47.47%) of them cultivating between 1 - 2ha of farm land. The farm size confirms that they were small-scale farmers and are the categories of farmer targeted for the study. The result on farm size agrees with the finding of NBS (2010b) which indicated that more than 90 percent of the agricultural output is accounted for by small-scale farmers with less than 2 ha under cropping.

Table 3 The socio-economic characteristics of small-scale farmers

Characteristics	Frequency	Percentage
Gender		
Male	337	77.65
Female	97	22.35
Marital status		
Single	28	6.45
Married	355	81.80
Divorced	20	4.61
Widow	31	7.14
Age group (years)		
≤ 30	22	5.06
31 – 40	120	27.65

41 – 50	182	41.94
> 50	110	25.35
Household size (number per household)		
1 – 3	44	10.14
4 – 6	137	31.57
7- 9	165	38.01
> 9	88	20.28
Literacy level		
No formal school	169	38.98
Primary school	97	22.35
Secondary school	110	25.35
Post-secondary school	58	13.36
Years of farming experience (years)		
≤ 10	47	10.83
11 – 20	127	29.26
21 – 30	149	34.33
> 30	111	25.58
Farm size (ha)		
≤ 1	70	16.13
1.1 – 2	206	47.47
2.1 – 3	107	24.65
> 3	51	11.75

Mean household size = 7 people	Mean farm size =2.36ha
Mean age = 46 years	Mean farming experience = 26years

Source: Survey data analysis, 2015

4.0 DISCUSSION

Over the last decade according to IFPRI (2014), there was an improvement in the production of all crop categories with root and tuber crops recording the highest growth (44%). Zakari, Mohammed, Medugu and Sandra (2014) indicated that Nigeria is leading in yam production with about 71 percent of total yam output coming from the country. This is an impressive record that needs to be maintained, however a key challenge revealed by this study is the crop damage caused by grazing livestock. The findings have opened a window for agricultural policy makers and planners to appreciate the challenges posed by grazing livestock especially cattle and goat/sheep in crop production.

Total cereal production in Nigeria in 2011 was 26.7 million tonnes; in 2012 it was 25.5 million tonnes; and in 2013 it was 26.6 million tonnes (FAO, 2013b). The greater proportion of this output may have come from the small-scale farmers. Balami, Ogboru, and Talba (2011) stated that cereals consist between 55 – 60 percent of subsistent farmers' output. Besides the important contribution of small-scale farmers, they are vulnerable to shocks and have limited ability to endure risk (FAO, 2012). The farmers cultivate both cereal and tuber crops that are very important in every society (Mairiga, 2014;

Balami, Ogboru, and Talba, 2011) and they depend on them for survival. Nevertheless, the damages on the crops caused by grazing livestock greatly affect the livelihood of farmers. Ofuoku and Isife (2009) stated that livestock farmers are transhumance in their quest for pasture and other necessities of life and hence can move from one location to the other. This is one of the major causes of conflict between pastoralist and farmers (Ofouku and Isike, 2009; Blench, 2010; Abbass, 2012). No farmer will be comfortable to lose a stand of his/her crop and watch the pastoralists move freely with their livestock herds.

The destruction of crops by grazing livestock is an additional risk that discourages the active participation of small-scale farmers. It acts as a disincentive as farmers will consider the likelihood of their crops being destroyed by grazing livestock (Audu, 2014). Actually, some crop farmers have resorted to reducing the planted hectarage as a coping strategy. This is reported in a study conducted by Adisa (2012) which showed that 24.2 percent of crop farmers in Kwara State were planting less in order to cope with the effects of the conflicts arising from crop damages. The true picture of the extent of crop damage can be seen if the stock figures are considered; these are: cattle (16,722,170), goats (57,937,176), and sheep (36,372,233) as documented by NBS (2012). The sum total for the three groups of livestock is 111, 031,579 and they are concentrated mostly in the northern part of Nigeria, hence the high rate of conflict due to crop damage (Abbass, 2012; Adebayo and Olaniyi, 2008). Where there is absence and/or non-adherence to grazing routes, the crop damage will be high. Unfortunately, some of the pastoralists are too young to be conscious of such issues during grazing.

The main issue in Nigerian agriculture is that of low productivity (Rahji and Omotesho, 2006). The farmers across all regions in the country are below their production frontiers and the impact of grazing livestock should be considered as one of the causes (Liverpool-Tasie, Kuku, and Ajibola, 2011). Ibrahim, Shamsudin, Yacob and Radam (2014) also stated that the impact of grazing livestock on crop production may have contributed to low technical efficiency recorded by farmers in northern Nigeria. This paints a gloomy picture, as the total output and productivity of farmers may fall below an economically acceptable level. In this context, crop production in Nigeria may not cope with population growth rate of 3.2 percent per annum (OPEC, 2013). This might imply importation of larger quantities of cereals to meet the demand of the growing population. FAO (2002) predicted that in 2030, developing nations (Nigeria inclusive) would increasingly depend on the importation of cereal crops. To counter this unfavourable prediction, one of the challenges that need to be addressed is the impact of grazing livestock, as noted by Liverpool-Tasie, Kuku, and Ajibola (2011) that there is room to increase agricultural productivity above existing levels even without a change in the farmers' levels of input use. Therefore, for Nigeria is to realize the goals set up in her Vision 20: 2020 on food production, the impact of grazing livestock on crop productivity has to be realistically and timely handled. A favourable policy environment is required so that both livestock and crop farmers can co-exist (FAO, 2002). Moreover, all other factors affecting crop production should be addressed (Isah, Samuel, Makama and Kiresur, 2015).

5.0. CONCLUSIONS/ RECOMMENDATIONS

5.1. Conclusion

In Nigeria, crops and livestock are produced mainly by small-scale farmers that are distributed all over the nation. The crop farmers cultivate small portions of land without fencing while their livestock counterparts rear few animals under extensive system, which lets the animals move around and feed with little or no form of restriction. This system of livestock production results in the destruction of crops and this causes conflict between crop and livestock farmers. This ugly scenario is detrimental to sustainable agricultural development hence the need to assess the impact of grazing livestock on cereal and tuber crops production in Abuja, Nigeria.

The study focused on small-scale crop farmers in agrarian communities from five (out of six) area councils in Abuja. The farmers were asked to rate the

impact of grazing livestock on crop production using a rating scale of 0 – 4. The data were analysed using both inferential and descriptive statistics with impressive results. First, there were significant locational differences in the impact of grazing livestock on cereal and tuber crops production. For cereal crops, the mean responses showed that kwali Area Council was the most affected location while Kuje and Abaji Area Councils had the highest impact on tuber crops. This implies that the impact of grazing livestock on cereal and tuber crops depends on the dynamics of livestock and crop production in each location and therefore, can be addressed based on prevailing conditions in such locations. The result also indicated that the level of destruction significantly depended on type of livestock and crop produced. For cereal crops, cattle and goat/sheep were rated as most destructive livestock while for tuber crops, it was cattle. Generally, the least destructive livestock was domestic fowls. The policy implication is that, while stricter measures to control the extensive system of livestock production are required, this might not be the case with domestic fowls.

Again, mean response showed that maize and cassava were the most affected cereal and tuber crops while the least affected were rice (cereal) and potato (tuber). This also connotes that rice and millet could be produced in some of the locations with minimal destruction from grazing livestock. In terms of cost estimate of damaged crops, the findings show that cassava farmers who were affected by grazing livestock lost an average of ₦11,745 (U$ 73) while potato farmers were the least affected, they lost an average of ₦3,679 (US$ 23). Based on the findings, it can be concluded that the impact of grazing livestock is one of the key factors limiting cereal and tuber crops production, though the magnitude of the impact depends on location, livestock type and crop cultivated. Considering the average farm size, it is clear that the

estimated cost of damaged crops was high, which is capable of eliciting aggressive response from the crop farmers.

4.2. Recommendations

Based on the findings, the following recommendations are made. The Federal Government of Nigeria should conduct a study to determine if the livestock farmers prefer grazing routes (option A) or are willing to adopt intensive system of livestock production (option B). Furthermore, the study should also find out how the various stakeholders perceive and prefer any of the options, and how they can be planned and implemented. This will help in addressing the impact of grazing livestock on crop production. The two options are spelt out below.

Option A: If grazing routes are preferred by the farmers (stakeholders):

- Government should establish a Rangeland and Grazing Routes (RGR) Commission that will be solely responsible for the demarcation, development, coordination and management of rangelands and grazing routes in Nigeria. The commission shall establish offices at the local government, state and federal levels and shall partner with the private sector. Bottom-up approach should be adopted in the demarcation of new grazing routes so that it will emanate from communities. In addition, there is need to establish Livestock Grazing Route Committees at community, local government and state levels.
- Government should set up a task-force involving government and non-governmental organisations (private sector) to create awareness and inform stakeholders of the locations, size and importance of the use of new and existing grazing routes. The information should be disseminated through mosques, churches, radio, TV, schools, chats, maps and meetings with crop and livestock farmers' unions in their various communities.

Option B: If intensive system of livestock production is preferred:

- Government should teach farmers to adopt intensive system of livestock management through Agricultural Extension Agents (Livestock Subject Matter Specialist). Various information and communication technologies (ICTs) can be used to document and disseminate simple and locally adaptable ways of intensive system of livestock production so that they can watch and learn at their convenient time e.g. using home videos and also mobile phone applications. This will make them to develop interest, try and practice intensive livestock production systems at their homes.
- The documentation should be done in various languages including English, Hausa, Yoruba, Igbo and any other language that the farmers can understand. It shall cover all livestock that have the potential to damage crops and cause problem in the society. Agricultural extension agents who are livestock subject matter specialist can be trained to handle the documentation.

Further studies

This study should be replicated especially in other northern states in Nigeria, so as to further understand this challenge. In addition, it should cover impact on water points, herbaceous plants, ornamental crops, agro-forestry, air pollution, and soil erosion.

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6.0 APPENDICES

6.1 Questionnaire

Impact of Grazing Livestock on Cereal and Tuber Crops Production in Abuja, Nigeria

Instruction: Please answer all the questions (Tick the appropriate answers)

1. What is the name of your Local Government area?
   .....
2. What is the name of your agricultural zone?
   .....
3. Gender (a) male…….. (b) Female……..
4. Marital status (a) single…….(b) Married…… (c) Divorced…… (d) Widow….
5. Household size? (a) No. of male children……. (b) No. of female children… (c) No. of maids…… (d) Others……..
6. Age ……years (please give your actual age)
7. How long have you being practicing agriculture?……years
8. Educational level (a) No school at all…… (b) Primary school……
   (c) Secondary school…… (d) Post-secondary Institution……
9. What is your average farm size?…… hectare
10. Apart from farming,, which other thing do you engage in?
    .....
11 In the table below, rate the level at which **Grazing Cattle Destroy** each of the crops in your area

Crops	Very highly destructive (4)	Highly destructive (3)	Moderately destructive **(2)**	Least destructive (1)	**Not destroyed at all (0)**

Maize					
Rice					
Sorghum					
Millet					
Yam					
Cassava					
Potato					

12. In the table below, rate the level at which **Grazing Goat/sheep Destroy** each of the crops in your area

Crops	Very highly destructive (4)	Highly destructive (3)	Moderately destructive **(2)**	Least destructive (1)	**Not destroyed at all (0)**
Maize					
Rice					
Sorghum					
Millet					
Yam					
Cassava					
Potato					

13. In the table below, rate the level at which **domestic fowls destroy** each of the crops in your area.

Crops	Very highly destructive (4)	Highly destructive (3)	Moderately destructive **(2)**	Least destructive (1)	**Not destroyed at all (0)**
Maize					
Rice					

Sorghum					
Millet					
Wheat		.			
Yam					
Cassava					
Potato					

14. In the table below, give an estimate of your crops destroyed in 2013 till date if you are affected. Please be very honest in your estimate.

Crops destroyed	**Estimate of the crop destroyed (₦)**
Maize	
Rice	
Sorghum	
Millet	
Yam	
Cassava	
Potato	

6.2 Maps of the study area

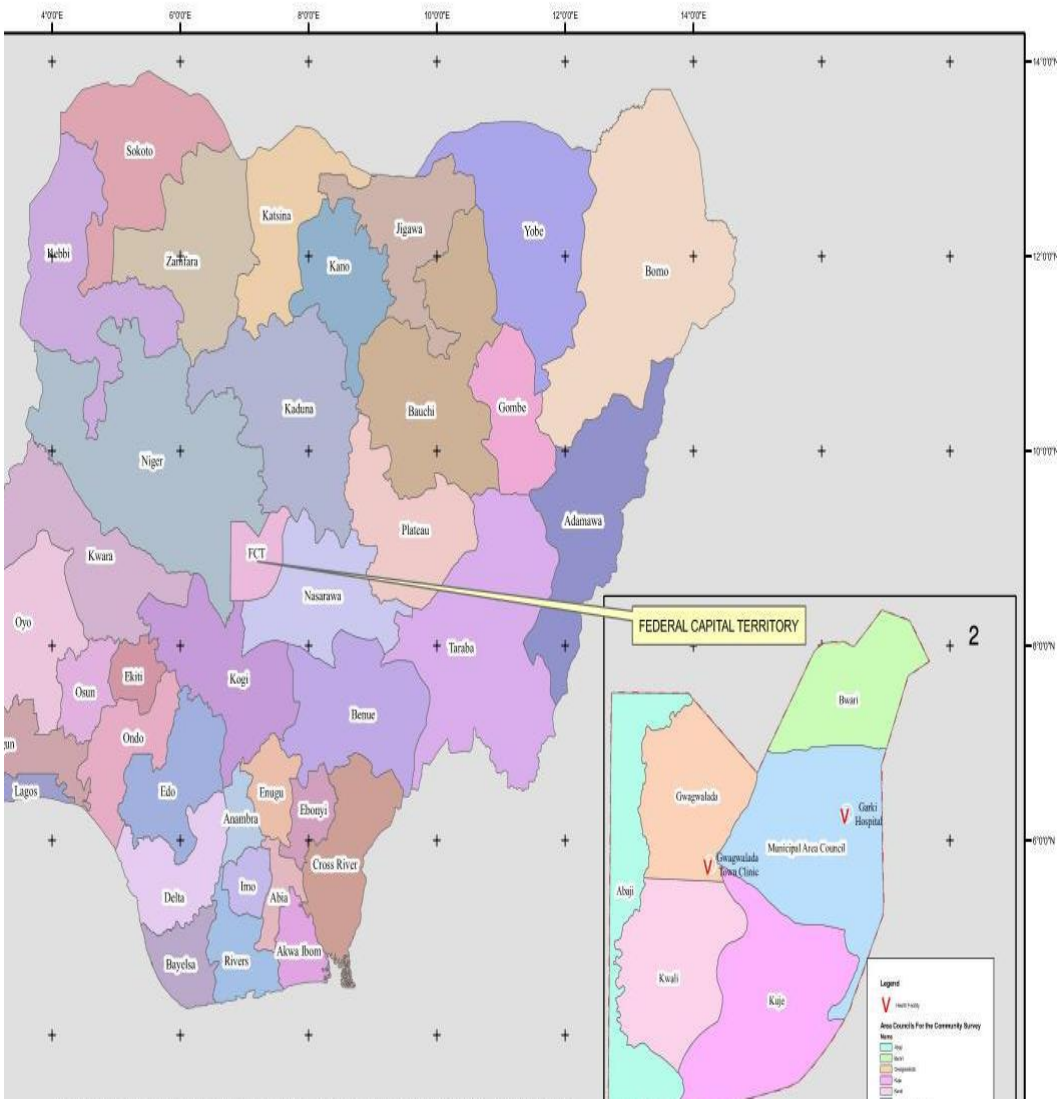

Fig. 30 Map of Nigeria showing study area
Source: Otsemobor, *et al*. (2013)

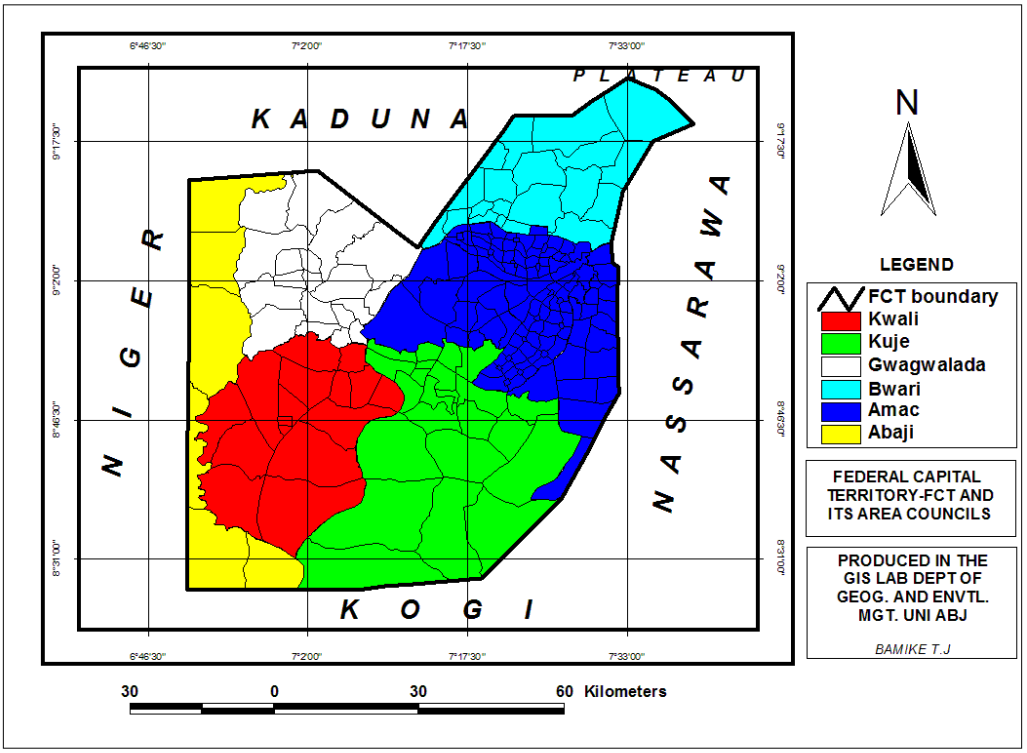

Fig. 31: Map of FCT showing the five locations where sampling was done
Source: Aondoakaa (2012)

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