ASSESSMENT OF FEED RESOURCES, MANAGEMENT PRACTICES AND MITIGATING STRATEGIES TO FEED SCARCITY IN GRASSCUTTER (*Thryonomys swinderianus*) PRODUCTION IN NORTH-WESTERN GHANA

Titus Stanislaus Saanaakyaavuure DERY[1], Christopher ADENYO[2,3], Boniface Baboreka KAYANG[4] & Miho INOUE-MURAYAMA[3,5]
[1]*Department of Animal Science, School of Agriculture, College of Basic and Applied Sciences, University of Ghana*
[2]*Livestock & Poultry Research Centre, School of Agriculture, College of Basic and Applied Sciences, University of Ghana*
[3]*Wildlife Research Center, Kyoto University*
[4]*Department of Animal Science, School of Agriculture, College of Basic and Applied Sciences, University of Ghana*
[5]*Wildlife Genome Collaborative Research Group, National Institute for Environmental Studies*

ABSTRACT Grasscutter farming is becoming common in Ghana. However, having access to sufficient and quality feed resources has been the major challenge for grasscutter production. To assess available feed resources, management practices and mitigating strategies to feed scarcity among grasscutter farmers, we interviewed 38 grasscutter farmers in the Upper West Region of Ghana. Fifteen local feed resources were identified as feedstuffs for grasscutters. Majority of farmers strongly agreed that their management practices were based on experiences from daily feeding (68.4%), education from field agents (78.9%) and cooperating with family members (65.8%). The majority of the farmers (71%) indicated inadequate rain in the dry season as the major cause of feed scarcity. Forty one percent of farmers traveled long distances to look for grasscutter feed while about 38% of farmers conserved feed toward feeding in the dry season. Grasscutter farmers must be encouraged to conserve adequate quantities of crop residues from cereals, legumes, roots and tubers and grass that are left in the field after harvest for feeding in the dry season. This study provides useful information on local feed resources and management practices that allow grasscutter production under the harsh environments in northern Ghana.

Key Words: Grasscutter; Feed resources; Management practices; Ghana.

INTRODUCTION

By the year 2050, the world food requirement would double that of 2010 and larger amounts would be from developing countries due to their rising human populations and urbanization. Two thirds of this demand need to originate from livestock production through feed efficient production and utilization such as forages and concentrates (FAO, 2012). Developing countries have the lowest protein intake in the world and this can be alleviated when domestication of rodents

is encouraged and improved due to their wide acceptance for consumptions in the third world countries (Tawah & Mbah, 1989). Among the rodents, the grasscutter (*Thyonomys swinderianus*) is the most preferred for consumption in many African countries (National Research Council, 1991; Boateng, 2005). Grasscutter is a wild rodent of the family Thyronomyidae which is widely distributed in sub-Saharan Africa (Wood, 1974). Although the genus *Thryonomys* has two species (*T. swinderianus* and *T. gregorianus*), *T. swinderianus* is much more common than the other species (Rosevear, 1969; Simpson, 1974). Grasscutter inhabits grasslands, secondary forests and woody humid areas in sub-Saharan Africa (National Research Council, 1991). It looks more like the porcupine than a rat, and the body length is up to 60 cm long, weighs up to 9 kg with 65% dressing excluding the offals (Odebode et al., 2011). Gestation period is about five months (Asibey, 1974; Addo, 2002). Grasscutters can give birth twice a year and the average litter size is four kids with birth weight at 70–130 grams each (Baptist & Mensah, 1986). The young ones are weaned after one month (Adu, 1999) and sexual maturity for female is six to eight months and seven to nine months for the males (Odusanwo, 2012). This high reproduction rate indicates the great potential for breeding (National Research Council, 1991; Boateng, 2005).

Grasscutter meat is in high demand in Central and West Africa. About 80 million grasscutters are hunted for meat every year in West Africa which is equivalent to 300,000 metric tonnes of meat (Louw, 2008). The demand for grasscutter meat is high because its consumption has no religious, sex, age and ethnic barrier. In Ghana, it is the most consumed bushmeat (Boateng, 2005). Similar to the conservation of other wildlife species and ruminants, keeping grasscutter in captivity entails significant investments of time and money (Tewe, 1997; Annor & Kusi, 2008).

Crop residues obtained after harvesting crops form an abundantly available feedstock for ruminant feeding (Schiere, 2010). Livestock farmers often resort to agricultural by-products like cereal crops, bran and legumes such as groundnuts and cowpea as animal feed (Gautier et al., 2005). However, variation in quantity, quality and seasonal shortage of feed resources are bottlenecks in ruminant production (FAO, 2012; Jimma et al., 2016). Assessing the existing feed resources for livestock production is therefore critical to efficiently manage these resources and reduce waste of feeds (Dore et al., 2011).

In Ghana, the livestock sub-sector is an important component of agriculture in the country. Livestock kept in Ghana are ruminants (cattle, sheep and goats), poultry (chicken, guinea fowl, ducks, turkey and ostrich among others), pigs and non-conventional species (grasscutter, snail, guinea pigs and rabbits). The keeping of livestock contributes significantly to the agricultural sector and serves as a major link in the Ghanaian farming and livelihood systems. Unlike poultry, there is no competition for feed with human beings in grasscutter production because they mostly eat grasses and agro by-products (Agbelusi, 2013). Grasscutter farming is common nowadays and it is farmed as a mini-livestock species in West and Central Africa (Opara & Fagbemi, 2008). Fortunately, the government of Ghana as well as foreign organizations like Japan International Cooperation Agency (JICA),

German Organization for Technical Cooperation (GIZ, formerly GTZ) have invested hugely on grasscutter domestication in efforts to improve rural livelihoods. Currently, Grasscutter Initiative for Rural Transformation (GIfT) is the only NGO that continues to support grasscutter production in the Upper West Region. As at June 2019, 62 grasscutter farmers had their breeding stock reproduce over 600 grasscutters since March, 2017 with continuous support from Ajinomto Foundation through GIfT. Through this project, fourteen individuals from both northern and southern regions have bought breeding stock from beneficiary farmers and started their own commercial production (Grasscutter Initiative for Rural Transformation, 2018).

Just as with other livestock, feed resources for feeding grasscutters are either unused or underutilized in many countries including Ghana as a result of lack of knowledge on these resources. Identifying the various feed resources, management practices and mitigating strategies used by grasscutter farmers to overcome feed shortage is important in order to develop appropriate research and interventions to enhance the healthy growth and effective reproduction of grasscutters. The aim of this study was therefore to identify the available feed resources, management practices and mitigating strategies to feed scarcity among grasscutter farmers in the Upper West Region of Ghana.

MATERIALS AND METHODS

I. Study location

The study was carried out in seven (comprising 18 selected communities) of the eleven districts in the Upper West region. The region is located at the northwestern corner of Ghana with latitude 9.8°–11.0° North and longitude 1.6°–3.0° West. It is bounded by Burkina Faso to the North and West, to the East by Upper East and Northern Regions, and to the South by Northern Region. Between March 2014 and February 2017 the Ghana Grasscutter Project supported by JICA introduced grasscutter rearing to this region and operated under the theme ‘enhancing livelihoods through improvement in native livestock production’. Then, since March 2017, the NGO GIfT has continued to support this grasscutter production initiative (Grasscutter Initiative for Rural Transformation, 2018). As a result of intensive support of grasscutter production, captive grasscutters in the region increased from 0 to 600 individuals in June 2019. The districts and communities involved in the project are shown in Fig. 1. They include Jirapa (Jirapa, Konzokala and Duori), Lawra (Lawra, Tuori and Tolibri), Lambussie (Lambussie, Piina and Karni), Nandom (Nandom, Vapuo and Kokoligue), Wa Municipal (Water Village and Chokor), Wa East (Bullenga and Loggu) and Sissala East (Tumu and Naveriwie). During the initial stage of the project, departments of Ministry of Food and Agriculture in the various districts selected three communities each from six districts, then three individual livestock farmers were selected from each community,

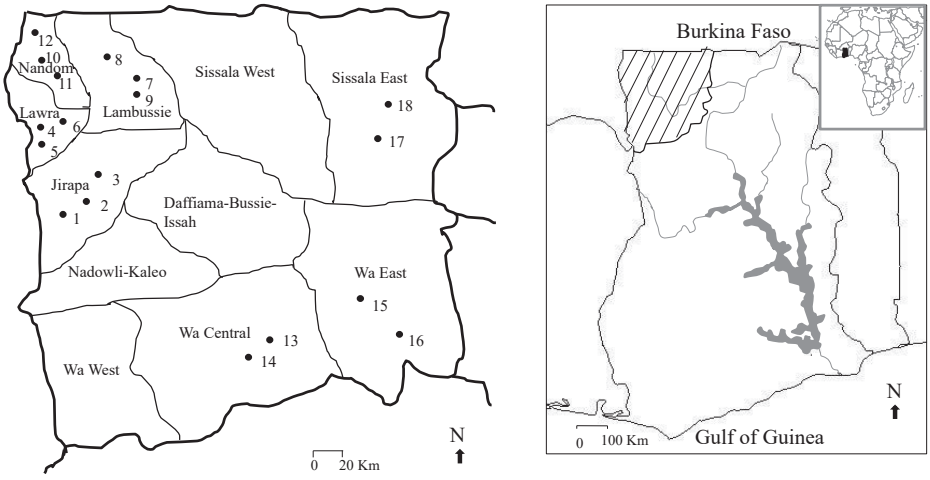

Fig. 1. Locations for interview surveys in the Upper West Region of Ghana.
Interviews were conducted at 18 communities in seven districts as follows: Jirapa (1. Jirapa, 2. Konzokala and 3. Duori), Lawra (4. Lawra, 5. Tuori and 6. Tolibri), Lambussie (7. Lambussie and 8. Piina and 9. Karni), Nandom (10. Nandom, 11. Vapuo and 12. Kokoligue), Wa Municipal (13. Water Village and 14. Chokor), Wa East (15. Bullenga and 16. Loggu) and Sissala East (17. Tumu and 18. Naveriwie).

one from each household making a total of nine livestock farmers as grasscutter beneficiary farmers from each district and a total of 54 grasscutter beneficiary farmers in all. Through the support of GIfT, one more district was added making a total of seven districts with 63 grasscutter beneficiary farmers. Data available from the JICA—Ghana Grasscutter Project showed that 38 active grasscutter farmers still existed in selected communities while the rest had stopped production. The study sample was therefore drawn from beneficiary farmers who had grasscutters at the time of the study in the communities. The districts are ethnically heterogeneous with 2013 projected total population of 26,427,760, 49% being males and 51% females. The region and all districts experience one rainy season which starts in May and ends in October every year. The vegetation is characterized by short widely spaced fire resistant trees. The soil surface is covered with grass species of different heights and normally left bare after bushfires in the dry season. Major food crops produced include maize, millet, sorghum, cowpea, groundnuts, rice, yam, pepper and okra. In addition, farm animals such as cattle, sheep, goats, pigs and poultry are kept. Many individuals keep their livestock under extensive system while few keep theirs under semi-intensive system. These practices make their competition with grasscutters for food low. Both crop and animals produced are for household consumption and sale.

II. Data collection

Data were collected by interviewing 38 farmers using a structured questionnaire. Information on feed resources, management practices and mitigating strategies were collected. The questionnaire was designed in English language and translated to local languages (Dagaare and Wali) for famers who could not speak or write English Language. Responses were then entered into the questionnaire in English language while some of the names of local feed resources were captured in their local languages and later identified by their botanical names.

III. Statistical analysis

Survey data were coded and analyzed using Statistical Package for Social Sciences (SPSS) version 16.0 for Windows. To examine the effects of the demographic traits of the respondents on their management practices in the grasscutter farming, we ran chi-square tests on associations between seven demographic variables (age, district, religion, marital status, dependents, educational level and occupation) and two selected management practices (feeding frequencies per day and presence of cooperation with families).

Microsoft Excel 2013 was used to generate graphs. The level of significance was set at $p \leq 0.05$.

RESULTS AND DISCUSSION

I. Demographic characteristics of respondents

Table 1 shows the demographic characteristics of grasscutter farmers in the study area. Grasscutter production spanned through all the classified age groups of respondents even though it appeared more likely among the active group (20–50 years), representing 84.2%. Grasscutter production continued in all the districts where they were initially introduced. About 61% of respondents were concentrated in Lambussie, Nandom and Jirapa districts. Majority of the respondents were Christians (76.3%) followed by Muslims (18.4%) and Traditionalists (5.3%). These distributions also reflect that of the national distribution of Ghanaians according to their religious beliefs based on Ghana's 2010 Population Census where Christians represent 71.2% of Ghana's population, while 17.6% are Muslims, 5.2% Traditional believers and other believers constituting 6% of the population (Ghana Statistical Service, 2013). The results suggest no limitation on grasscutter production by religion. Table 1 also shows that majority of those who kept grasscutters were married (89.5%) while 2.6% were single. Also, 89.5% of respondents had six or more dependents. About one-third of respondents never had formal education while 21% had only basic education. The rest had formal education up to the Senior High School level (15.8%) or up to tertiary level (31.6%). Among all the grasscutter farmers, those whose profession was only farming represented about 66% while 34% of the grasscutter farmers were into farming while being engaged

Table 1. Demographic characteristics of respondents (n = 38)

Variable	Respondents	Percent (%)
Age Group (Years)	–20's	7.9
	–30's	28.9
	–40's	31.6
	–50's	23.7
	–60's	7.9
District	Wa East	13.2
	Lambussie	15.8
	Nandom	21.1
	Jirapa	23.7
	Lawra	13.2
	Tumu	10.5
	Wa Central	2.6
Religion	Christianity	76.3
	Muslim	18.4
	Traditional	5.3
Marital status	Single	2.6
	Married	89.5
	Separated	2.6
	Widowed	5.3
Dependents	<6	10.5
	6–10	63.2
	>10	26.3
Educational Qualification	None	31.6
	Basic Education	21.0
	Senior High School	15.8
	Tertiary Education	31.6
Occupation	Farmer	65.8
	Educator	18.4
	Agribusiness representative	10.5
	Student	2.6
	Other (carpentry)	2.6

in other professions such as teaching, agribusiness representative, schooling and carpentry for additional income.

II. Feed resources available to grasscutter farmers

Grasscutters can effectively utilize fibrous forages with a digestibility coefficient for Neutral Detergent Fiber (NDF) and protein higher than those for rabbits, and more similar to hystricomorph rodents (Van Zyl et al., 1999). Fresh forages become abundant in the rainy season therefore need to be conserved for dry season feeding (Adegbola, 1998). During the dry season, green forages and grass species die due to drought and most at times get burnt as a result of bush fires, hence the amount of feed resources available decrease substantially. Farmers therefore rely heavily on the roots of grass species, agro by-products, legumes and cereal crop residues to feed their grasscutters. However, the nutritional qualities in natural

Table 2. Local feed resources available for grasscutter production based on the interviews of 38 farmers

Scientific name	Family name	Common name	Local name (Dagaare/Wali)	Part fed to grasscutters	Percent (%)
Zea mays L.	Poaceae	Maize	Kamaani	Stalks/grains/husks	94.7
Andropogon gayanus	Poaceae	Gamba grass	Mie/gbatiile/ sanpanti	Straw/roots	50.0
Chrysopogon zizanioides	Poaceae	Vetiver	Gyilmie/Kentere	Straw/roots	42.1
Rottboellia cochinchinensis	Poaceae	Itchy grass	Kalnyaan	Straw/roots	39.5
Pennisetum glaucum	Poaceae	Fountain grass	Sambala	Straw/roots	34.2
Oryza sativa	Poaceae	Rice	Mune	Straw/leaves	21.1
Panicum maximum .	Poaceae	Guinea grass	Mopila	Straw/leaves	15.8
Arachis hypogeae	Fabaceae	Groundnut	Singkaa/Simie	Haulm/seeds	10.5
Sorghum bicolor	Poaceae	Sorghum	Naara/kyere/ dawole	Stalks/leaves/ brewers spent grain (pito mash)	10.5
Imperata cylindrica	Poaceae	Spear grass	Pulong	Straw/roots	10.5
Phaseolus coccineus	Fabaceae	Runner beans	Bege	Haulm/leaves	7.9
Dioscorea oppositifolia	Dioscoreaceae	Yam	Waare/woo	Vine/peels	5.3
Hydrilla verticillata	Hydrocharitaceae	Hydrilla	Vamal	Stem/leaves	5.3
Manihot esculenta	Euphorbiaceae	Cassava	Bankyin	Stem/roots/peels	2.6
Moringa oleifera	Moringaceae	Moringa	Wobnyukuo	Branch	2.6

Multiple responses (n = 134)

pastures and crop residues often reduce and cannot provide important nutrients such as energy, protein, minerals and vitamins in adequate amounts in the dry season (Dixon & Egan, 1987).

Table 2 shows multiple responses on the local feed resources that are fed to grasscutters in the study area. Fifteen different dry and fresh forages and grass species representing seven families were identified among grasscutter farmers with Poaceae being the major feedstuff. This is in agreement with a study by Adenyo et al. (2016) that showed that 54 different families of plants are eaten by wild grasscutters with Poaceae (grasses) being the major feedstuff. Majority of the feedstuffs fed to grasscutters were grass species. The parts of local feeds fed to grasscutters constitute 32 feed items. All the 38 farmers mentioned more than one local feed resources used in feeding their grasscutters.

Livestock feeds which are mostly forages are usually in low quantities in the dry season. The quality also reduces and cannot provide sufficient nutrients to livestock (International Livestock Research Institute, 2009; Jimma et al., 2016). Available feed resources are fed to grasscutters either in their fresh or dry state. The use of grass roots is gaining prominence because during the dry season most of the stems are either burnt by bush fires or eaten up by other ruminant livestock leaving the roots and base of the grass. Crop residues constitute substantial

amounts for livestock feeds (Dixon & Egan, 1987) although they have low digestibility and lack essential nutrients (Wanapat et al., 1997), they are the parts that become available after harvest (Dixon & Egan, 1987; de Leeuw, 1997; Yayneshet, 2010). Insufficient feed is a major challenge in grasscutter production (Ogunjobi & Inah, 2008). Besides, there is little knowledge in the feeding standards for grasscutters and the methods for feeding them also remain rudimentary and insufficient for production (Adu, 1999). Fig. 2 shows the monthly percentages of feed resource availabilities for grasscutters in different feed resource groups. Fresh green feed resources are highly available between May and November with the peak abundance from June to October due to the frequent rainfalls (Fig. 2a). Grasscutter farmers therefore have difficulties in getting fresh feed resources only in the dry periods. Livestock production has been greatly reduced by forage shortage both in quality and quantity during the dry season (Fernandez-Rivera et al., 2005; FAO, 2012; Jimma et al., 2016) and such feed shortage is the major constraint to improve the livestock sector generally (Adugna et al., 2012; FAO, 2012; Jimma et al., 2016). The feed that is usually available in the dry season is mainly for maintenance (Jimma et al., 2016). Because they are dry, high in fiber and low in nutrients, these fibrous forages take longer time to be digested and utilized by livestock resulting in loss of weight and reduced production. In such situations, the introduction of microbial digestive enzymes to hasten the digestibility of roughages fed to livestock is suggested in order to increase nutrient intake and production (Alemu, 2008).

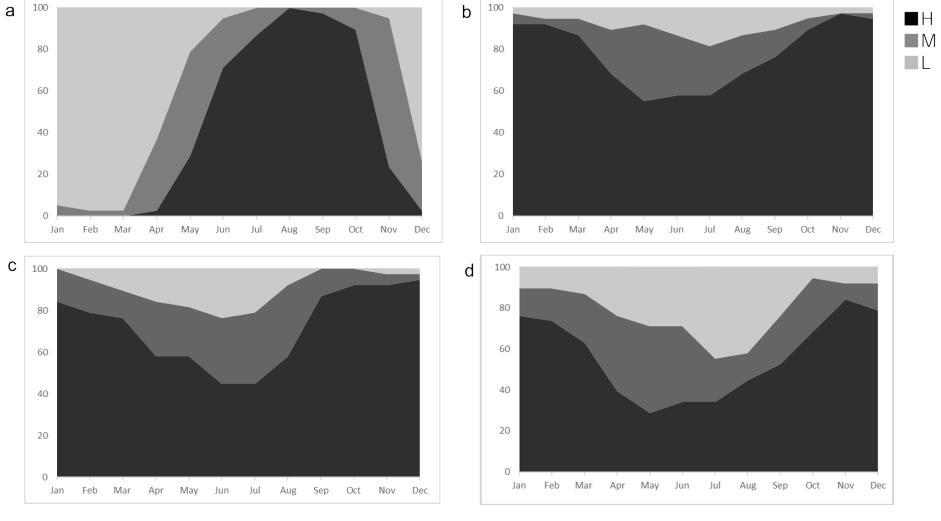

Fig. 2. Percent responses on periodic amounts of commonly available feed resources in the year.
a) green forages, b) cereal crops, c) legumes, and d) roots and tubers. H: High availability; M: Medium availability; L: Low availability of the feed resource for the stated months.

Cereal crops such as maize, rice and sorghum become available throughout the year (Fig. 2b). This is because every grasscutter farmer cultivates one or more of these crops for both consumption and sale. They become abundant at harvest from September till April. After April, the availability decreases due to consumption and sales while some are reserved for cultivation from May to August. Similar to the case of cereal crops, legumes such as beans and groundnuts, are also available throughout the year (Fig. 2c). They are in abundance from September to April and decline from May to August due to consumption, sales and reservation as planting seeds. However, the legumes are not used frequently as grasscutter feed and only groundnuts and beans are fed to grasscutters occasionally. There is abundance of roots and tubers such as cassavas and yams, lasting for seven months from pre-harvest in September, actual harvest in October to post-harvest up till March. Much of them are consumed during the seven months period resulting in reduction in quantities from April to August (Fig. 2d).

III. Factors considered for effective feeding of grasscutters

Table 3 shows the factors in decision making by grasscutter farmers for effective feeding. The result shows that all factors were ranked as very important with

Table 3. Factors considered for effective feeding of grasscutters based on the interviews of 38 farmers

	Rank (%)			
Factor	Not important	Important	Very important	Reasons for the decision
Quantity of feed to give	0.0	15.8	84.2	- For satisfaction
Quality of feed to give	0.0	5.3	94.7	- For rapid growth, reproductions and disease prevention
Source of feed	0.0	5.3	94.7	- Easy access and traceability
Type of feed	0.0	13.2	86.8	- For preference and variety
Freshness of grass	0.0	10.5	89.5	- For higher feed intake and fast growth
Nutritional Knowledge of the feed	0.0	23.7	76.3	- For good health and reproduction
Parts of grass fed to grasscutters	2.6	10.5	86.8	- For higher feed intake
Availability of reserve feed	2.6	23.7	73.7	- Reducing cost of transportation and for emergency
Provision of drinking water	0.0	13.2	86.8	- For digestion, growth and cooling the body

their associated reasons for each of them. All the farmers considered the quantity of feed for satisfaction, the quality of the feed for growth and disease prevention, the sources (place for feed supply such as river side, crop fields, etc.) where they gathered the feed to enable traceability, the type of feed (grass species, agricultural by-products, etc) according to the variety of feed eaten most by grasscutters, the freshness of the feed for higher feed intake, their knowledge of the nutrition of the feed for healthy growth and reproduction and water to enable digestion and cooling of bodies. These decisions are similar to the results of a study by Adu (1999) who asserted that ample feeding both in quality and quantity is required to improve the nutrition and productivity of animals in captivity. Underfeeding animals in captivity leads to deaths and low birth rates. Adegbola (2002) reported that fresh grasses are usually rich in nutrients and are consumed more than matured and dried plants.

IV. Grasscutter farmers' self-evaluation on general knowledge and management practices

Grasscutter farmers were asked to indicate their self-evaluation on some factors on their general knowledge and management practices in grasscutter farming. In Table 4, all the farmers either agreed or agreed strongly that their management practices resulted from their own experiences from daily feeding of their grasscutters, education from grasscutter field agents, taking their own initiative to solve nutritional challenges, cooperation with family members and other colleague farmers, goal setting on solving feeding challenges and being motivated by the prospects of grasscutter farming. Less than half of the farmers obtained knowledge on grasscutter farming through Ministry of Food and Agriculture (MoFA) extension officers and the media. Since grasscutter field agents do monthly monitoring of grasscutters, many MoFA extension officers might see no need to visit the farmers for the same activity. Also, since most of the farmers did not have higher education, they might not be able to read from the media to draw knowledge on grasscutter farming. Extension services enhance agricultural productivity by increasing technological transfer and by increasing farmers' knowledge on farm management practices (Waddington, 2010). However, many farmers usually rely on their experiences or family members on farm management practices (Ingram et al., 2010) and will only tend to get consultancy services when they fail to get the needed services from their experiences, family or peers (Klerkx & Proctor, 2013). In many European countries, many farmers rather seek agricultural advisory services from private companies offering those services (Oreszczyn et al., 2010) than from public institutions (Swanson & Rajalahti, 2010). Evenson (2005) reported that skilled and literate farmers seek knowledge on their own and hence only the less educated mostly seek farm management practices from extension services. The use of social media to access agricultural knowledge and innovative techniques has been stifled due to poor internet connectivity in many cases and the absence of knowledge to use them (Rose, 2016).

Table 4. Grasscutter farmers' self-evaluation on general knowledge and management practices based on the interviews of 38 farmers

Factor	Ranks (%)				
	Strongly disagree	Disagree	Agree	Strongly agree	No opinion
Practical experiences from daily feeding	0.0	0.0	31.6	68.4	0.0
Knowledge obtained from the advice of field agents	0.0	0.0	21.1	78.9	0.0
Knowledge obtained from MoFA Extension officers	15.8	26.3	34.2	7.9	15.8
Knowledge obtained from print media, internet or workshop	5.3	31.6	21.1	21.1	21.1
I take initiative for finding tasks and solving nutritional problems of my grasscutters	0.0	0.0	36.8	63.2	0.0
I am able to cooperate with my family and colleagues to solve nutritional challenges during dry seasons	0.0	0.0	34.2	65.8	0.0
I set a goal by myself and be patient and brave to deal with the feeding challenges of my grasscutters	0.0	0.0	39.5	60.5	0.0
I am motivated with the prospect of my grasscutters	0.0	0.0	28.9	71.1	0.0

V. Farmers' indicators of feed quality assessment for grasscutters

Grasscutter farmers were asked to give physical description of feed quality using the moisture, age at harvest, odor of feed, animals' behavior toward feed, coloration and stem to leave ratio of forages. In Table 5, grasscutter farmers reported that fresh succulent stems and roots of grasses with crunchy bites were preferred by grasscutters to very soft leaf parts that do not have any biting sound or rough in texture. This is in agreement with the report by Adegoke & Abioye (2016) that fresh chewy forages are of higher quality than rough or dried hard forages. According to Adegbola (2002), mature grasses in the dry season are highly lignified, unpalatable, and indigestible and are consumed less by ruminants as compared to fresh succulent forages that are young with higher moisture content, resulting in reduced growth and performance of animals in the dry season. Feed with bad smell were often not eaten by grasscutters and were therefore rated as poor-quality feed. In terms of animal behavior toward feed, grasscutter farmers reported that higher consumption of quality feed and the ability of the grasscutter to eat feed from a farmer's hand without being frightened indicated the quality of the

Table 5. Farmers' indicators of feed quality assessment for grasscutters

Indicator of quality	Representative description of quality by a majority of farmers
Texture	- Crunchiness (farmers reported that feeds that are crunchy chewy especially the stocks and roots of fresh succulent grasses are of higher quality than dry, rough feeds or very soft feed
Moisture	- Fresh forages improve feed intake
Age at harvest	- Forages that have not flowered yet (stems/stocks) were rated to higher in quality than old stalks.
Odour of feed	- Grasscutter farmers reported that fresh non smelling forages were of higher quality. Grasscutter will not eat unpleasant smelly feed.
Grasscutter behavior toward feed	- Higher feed intake was reported to show higher quality of feed. Grasscutters moves toward farmer and take feed from hand
Colouration	- Green forages were consumed more and showed higher quality than older yellow and brown stocks
Stem to leave ration	- Grasscutters preferred broader stem and leaves which indicated higher quality feed

feed and the desire of the grasscutter to have the feed. In a study by Tunde and Ayantunde (2016), green forages were ranked as the best indicator of feed quality for livestock production. Similar report has been given by Berhanu et al. (2009) using visual observation and smell of forages. However, Ball et al. (2001) reported that color alone cannot be an indicator of forage quality. Leaves of forages are known to contain more nutrients than the stem (Bakoglu et al., 1999) and livestock such as sheep and cattle consume more leaves than other parts of plants as indicator of good quality (Minson, 1980). However, the result in Table 2 shows that grasscutter farmers fed their grasscutters with the stalks and roots of forages more than the leaves. This may be due to their preference for crunchy chewy feed to soft feed such as the leaves.

VI. Causes of feed resources scarcity in grasscutter production

Table 6 shows multiple responses on the causes of feed scarcity for grasscutter production. Lack of rain during the dry season is the major cause for feed resource scarcity in the Upper West Region. This is due to the single rainy season with

Table 6. Causes of feed resources scarcity for grasscutters based on the interviews on 38 farmers

Category	Percent (%)
Lack of rain in the dry season	78.9
Wastage of feed by grasscutters	15.8
Bushfires destroy forages	7.9
Lack of vehicle to transport feed	5.3
Conventional animals eat all the forages around	2.6

Multiple responses (n = 42)

around 1,100 mm of annual rainfall in the region. Grasscutters like to eat thick stemmed grass species (Schrage & Yewadan, 1999), with high moisture (Onadeko, 1996) and mostly refuse the leaves, hence waste feed (Schrage & Yewadan, 1999). However, wastage of feed by grasscutters was recognized as a minimal cause of feed scarcity because grasscutters are able to eat all parts of the forages. This may be because of the little choice they have out of the forages presented to them especially in the dry state.

VII. Major problems identified by grasscutter farmers and proposed solutions

In Table 7, feed scarcity in the dry season was ranked as the major problem faced by grasscutter farmers. Such seasonal feed scarcity was also reported in the several studies on ruminant breeding (Ogunbosoye & Babayemi, 2010; Duguma & Janssens, 2016). Unavailability and poor quality of forages during the dry seasons affect livestock production (Ogunbosoye & Babayemi, 2010). As forages mature, they become unpalatable and the nutrient content decreases and therefore ruminants gradually begin to refuse the consumption (Babayemi et al., 2014). Ruminants will always select forage parts with high nutrient value (Babayemi & Bamikole, 2006). However, managing livestock forages can effectively complement feeding during the scarce periods through making pellets, hay or silage which can be conveniently stored and used in the dry season (Ajayi et al., 2008).

Mortality was the second major problem reported by grasscutter farmers. Recently, the monitoring of grasscutter populations in captivity over 10 years revealed a number of causes of deaths, such as pneumonia, cannibalism, traumatic injuries, respiratory tract infections, worm infestation, forced weaning, bloat and paralysis of the neck. However, some mortalities could not be attributed to any of the causes

Table 7. Major problems identified by grasscutter farmers and proposed solutions

Ranks	Major problems identified by grasscutter farmers	Percent (%)	Representative solutions proposed by grasscutter farmers
1	Scarcity of feed during dry season	86.8	- Conservation of feed, gardening in the dry season and formulating feeds using pito spent, machine waste and dawada flour
2	Mortality	76.3	- The need for veterinary services and good management practices (good feed and clean water), separation to avoid cross infection, separating males to avoid cannibalism, avoid feeding with contaminated feed
3	Aggressiveness	63.2	- Constant interaction with grasscutters, put more grasses in the cage for grasscutters to hide
4	Low productivity	52.6	- Research needs to be done to improve breeding.

identified. The major death of grasscutters resulted from pneumonia while the lowest cause of death was due to forced weaning. In this study, grasscutter farmers felt that veterinary services and hygienic practices could solve the mortality of grasscutters arising from infections.

Several factors cause traumatic injuries in captive grasscutters including competition, aggression, and stress (Akinyemi et al., 2016). Aggressive behavior by animals in captivity such as expression of body size, face and release of chemicals could frighten others causing them to jump and hit themselves resulting in injuries and death (Van Staaden et al., 2011). Aggressive behavior leading to injuries and death has been reported in captive grasscutters (Jori et al., 2001; Mensah et al., 2005). Several studies have been conducted to minimize aggression in caged mice. Some solutions to reduce aggressions include filling of nestling materials for the weaker ones to hide during attack and isolation of individuals (Van de Weerd et al., 1997; Ambrose & Morton, 2000) and the use of complex cage system which include many dividers for routes of escape and for exploration (Van Loo et al., 2001; 2003; Chamove, 1989). The proposed solutions by grasscutter farmers in this study include close contacts and interaction with grasscutters and putting enough nestling materials for grasscutters to hide during fright caused by strangers or unusual sound close to their housing.

VIII. Mitigating strategies to feed scarcity for grasscutter production

Grasscutter farmers employed five ways to solving the feeding challenges of their grasscutters during the feed scarcity in the dry season (Table 8). Majority of grasscutter farmers however tend to travel to distant places to fetch the feed or to conserve the feed during peak periods for use in the lean season. Because the total number of responses was 39 from 38 farmers, individual farmers do not use multiple strategies. In the Upper West Region of Ghana, many agro by-products such as pito spent, waste flour from milling machines, legumes and grains are readily available for many households to feed domestic animals. These feeds are not necessarily for sale and may be the reason for many farmers not purchasing agro by-products as a mitigating strategy.

Table 8. Mitigating strategies to feed scarcity for grasscutter based on the interviews of 38 farmers

Category	Percent (%)
Travel long distance to fetch	42.1
Feed conservation	39.5
Do dry season gardening	13.2
Pay boys to fetch from sources	5.3
Purchase of agro by-products	2.6

Multiple responses (n = 39)

IX. Association between demographic variables and management practices

Table 9 shows the associations between seven demographic variables (age, district, religion, marital status, dependents, educational level, and occupation) and four selected management practices. There was a significant association between educational level of respondents and the number of times they fed their grasscutters in a day. Respondents who had minimal educational level were likely to do farming as their primary occupation and are able to feed grasscutters more frequently than the respondents with higher educational levels who often have less time for grasscutter feeding due to their other main occupations (Table 10).

The cooperation with family was also affected by the educational level of the respondents. The farmers with low educational level tended to have stronger family cooperation (Table 11). These two results implicate that the rural farmers with minimal educational level can be efficient grasscutter farmers who can apply management practices more carefully to overcome the feed scarcity.

Table 9. χ^2 test for selected grasscutter management practices on demographic characteristics

Cross tabulation dependent variable	Demographic variable	χ^2	Likelihood Ratio	P-value
Number of times fed in a day	Age	10.987	11.392	0.530
	District	16.108	16.289	0.585
	Religion	7.338	6.746	0.291
	Marital status	1.192	2.013	0.999
	Dependents	3.156	4.662	0.789
	Educational level	22.272	18.908	0.008*
	Occupation	12.806	10.996	0.383
Cooperation with family	Age	4.679	5.390	0.322
	District	7.852	7.964	0.249
	Religion	1.066	1.659	0.587
	Marital status	7.372	8.099	0.061
	Dependents	4.176	3.916	0.124
	Educational level	8.302	10.414	0.040*
	Occupation	2.112	2.644	0.715

*P-values < 0.05 are statistically significant

Table 10. Daily feeding of grasscutters based on the educational level of 38 farmers

	Number of times fed in a day			
	Once	Twice	Thrice	More than thrice
Educational level	Percent (%)			
No formal education	0.0	28.9	2.6	0.0
Basic education	2.6	10.5	7.9	0.0
Senior High School	0.0	7.9	2.6	5.3
Tertiary	0.0	31.6	0.0	0.0

Table 11. Cooperation with family members based on educational level of the 38 farmers

	Cooperation with family			
	Strongly disagree	Disagree	Agree	Strongly agree
Educational level	Percent (%)			
No formal education	0.0	0.0	10.5	21.1
Basic education	0.0	0.0	0.0	21.1
Senior High School	0.0	0.0	2.6	13.2
Tertiary	0.0	0.0	18.4	13.2

CONCLUSION

The ability to overcome the issues of feed scarcity demands correct assessment of available feed resources that are eaten by grasscutters both in the rainy and dry seasons. Grasses (Poaceae) constituted the major feed for grasscutters both in the rainy and dry seasons and these are substantially complemented with cereals, legumes, roots, tubers and their residues. Grasscutter farmers improved their management practices through daily feeding, cooperation from family, education from grasscutter field agents and advice from colleague farmers. Fresh, green, crunchy forages were identified by the farmers to be of higher quality for feeding grasscutters. The major problems encountered by grasscutter farmers include feed scarcity in the dry season, mortalities, aggressiveness and low production. Since cereals, legumes and roots and tuber residues are abundant in the dry season, grasscutter farmers must be encouraged to conserve adequate quantities of these feed resources and grass species eaten by grasscutters that are left in the field after harvest (which mostly get wasted) for feeding their grasscutters during the dry season. The findings from this study can be applied in grasscutter farming in other regions of Northern Ghana which have similar climatic conditions to Upper West region.

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Corresponding Author's Name and Address: Miho INOUE-MURAYAMA, *Wildlife Research Center, Kyoto University, 2-24, Tanaka-Sekiden-cho, Sakyo, Kyoto 606-8203, JAPAN.*
E-mail: mmurayama [at] wrc.kyoto-u.ac.jp

ASSESSMENT OF FEED RESOURCES, MANAGEMENT PRACTICES AND MITIGATING STRATEGIES TO FEED SCARCITY IN GRASSCUTTER (*Thryonomys swinderianus*) PRODUCTION IN NORTH-WESTERN GHANA

Contact:
Dery Titus S.S.
0207452002 / 0246856786

SECTION A

PERSONAL DETAILS OF RESPONDENTS (PLEASE TICK WHERE APPROPRIATE).

1. Gender (male) (Female)
2. Age group (Below 20) (21–30) (31–40) (41–50) (51–60) (61–70) (Above 70)
3. District (……..)
4. Religion (Christian) (Muslim) (Traditional) (Other, please specify……..)
5. Marital status (Single) (Married) (Separated) (Divorced) (Widowed)
6. How many dependents do you have?
7. What is your highest educational qualification?
   (None) (Basic education) (Senior High) (Tertiary)
8. How would you describe your occupation? (Check all that apply)

(a) Farmer (b) Educator (c) Researcher (d) Agribusiness Representative (e) Farm Consultant
(f) Student (g) other: (please explain)

SECTION B

THIS SECTION ASSESSES THE TYPES OF FEED RESOURCES AVAILABLE IN YOUR LOCALITY, FEED QUALITY AND QUANTITY

9. What are the names and parts of grasses, other forages and by-products that you feed your grasscutters with? Write as many as you can remember in the box in your local language or English

10. Indicate the most commonly available feed resources in the months of the year in the table below using the scale of 1 to 3, where 1 = low availability, 2 = medium availability and 3 = high availability and give specific examples for each feed resources.

Month	Green forages	Cereal crop residues	Legume residues	Roots and tubers	Commonly available feed resources
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

11. Which part of fresh grasses or forages do your grasscutters eat most?
12. Which part of dry grasses or forages do your grasscutters eat most?
13. How many times do you feed your grasscutters?

SECTION C

THE FOLLOWING QUESTIONS PERTAIN TO YOUR KNOWLEDGE AND FEED MANAGEMENT PRACTICES OF YOUR GRASSCUTTERS

14. Rate the importance of the following factors in your decision when feeding your grasscutters and indicate the reason for your decision

	1	2	3	Write
	Not important	Important	Very important	Reason
Quantity of feed				
Quality of feed				
Source of feed				
Type of grass				
Freshness of grass				
Nutritional knowledge of the feed				
Part of grass fed to grasscutters				
Availability of reserve feed				
Provision of drinking water				

15. Indicate the extent of your agreement with the following statements concerning self-evaluation on general knowledge and management of your grasscutters

	Strongly disagree	Disagree	Agree	Strongly agree	No opinion
Practical experiences from daily feeding					
Knowledge obtained from the advice of field agents					
Knowledge obtained from MoFA AEA					
Knowledge obtained from print media, internet or workshop					
I take initiative for finding tasks and solving nutritional problems of my grascutters.					
I am able to cooperate with my family and colleagues to solve nutritional challenges during dry seasons					
I set a goal by myself and be patient and brave to deal with the feeding challenges of my grasscutters					
I am motivated with the prospect of my grasscutters					

16. Indicate your knowledge on your assessment of quality feed by writing your reason against each indicator of quality in the box.

Indicator of quality	Description of quality
Texture of feed	
Moisture	
Age at harvest	
Odour of feed	
Animal behaviour	
Colouration	
Stem to leave ratio	

SECTION D

THIS SECTION ASSESSES THE STRATEGIES YOU ADOPT WHEN FEED IS SCARCE

17. What do you think are the constraints to feed resources availability?
18. What are the feed compositions during feed scarcity? Write them in the box

19. Write four major problems identified in grasscutter production and propose solutions to these problems in rank order in the table below.

Rank order	Problems identified	Proposed solutions
1		
2		
4		
4		

20. How do you overcome the constraints of feeding your grasscutters?

THANK YOU FOR YOUR TIME