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Factors Influencing Changing Boundaries and/or Routes of Fulani Herders in the North Eastern Corridors of Ghana: A Count Model Approach

Nanii Yenibehit [a*], Joseph Amikuzuno [a,b] and Abdulai Abubakari [b,c]

[a] Animal Health and Production College, Pong Tamale, Ministry of Food and Agriculture (MoFA), Tamale, Ghana.
[b] St. John Bosco College of Education, Navrongo, Upper East Region, Ghana.
[c] Institute for Interdisciplinary Research (IIR), University for Development Studies, Tamale, Ghana.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was designed to examine the factors influencing the movement or changing of herding routes among herders in the North – Eastern corridor of the Northern and Northeast Regions of Ghana. The study followed a cross-sectional descriptive survey research design and adopted the Poison and Negative Binomial regression Models. A total of 210 Fulani herders and seven community/opinion leaders from seven communities across four (4) districts were randomly selected for this study. Duration of a herder's stay in a community (P≤.01), being given a range of land for kraaling or grazing (P≤.01), having access to education for children (P≤0.1), losing cattle before (P≤.01) and ever being harmed or witnessing same due to conflict (P≤.01) are important factors that prevent or reduce the number of times a herder changes location or route. On the other hand, factors including hired herding (P≤.01), years of education of a herder (P≤.05) and restriction or lack of grazing land for cattle (P≤.1) are some of the most compelling factors that lead to changes in location or herding routes of Fulani herders. Fulani herders should be registered and integrated into the various communities whilst encouraging them to educate their children and have permanent living status.

**Corresponding author: E-mail: yenibehitnanii@gmail.com;*

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1. INTRODUCTION

The whole world is experiencing unprecedented population growth coupled with changing eating and lifestyles and increasing demand for bioenergy. This has exerted pressure on agricultural production systems, including crop production and pastoralism. The intensification of agriculture and farming has become a blueprint for meeting the increasing demand for food resulting from the ever – growing population [1].

In the same vein, croplands in West Africa, including Ghana, are expanding to meet the food and meat needs of the burgeoning population of the sub-region. Aside from its negative repercussions on the ecosystem, water and soil quality, the increasing size of agricultural activities has also led to an increasing level of conflicts between crop farmers and animal herders [2]. It is an undisputable fact that the competition for resources for crop production and animal production has further aggravated these conflicts.

This is the case of Fulani herders and crop farmers in the coastal regions of most parts of West Africa, including Ghana. In recent times, conflicts between crop farmers and animal herders, especially nomadic and/or sedentary Fulani herders have increased. The empirical literature attributes the main cause of the herder-farmer conflicts in Ghana to the destruction of crops by cattle [3-5]. Herders often leave their cattle unattended, which wander into homesteads or bush farms to destroy farmers' crops. Besides, herders allow their stock to roam freely in the off-farm season. This leads to the destruction of dry season irrigation farms along the Volta Basin and results in conflicts with farmers. Other sources of conflicts between indigenous farming communities with the nomadic herders include general suspicions of crimes of rape, arm robbery, stock theft by herders, and accusations of herders of exploitation by indigenous stock owners [3].

Herder-farmer conflicts have caused national and sub-regional policy problems for the government of Ghana (GoG), which has struggled since the turn of this century to find sustainable solutions to the problem [4]. In particular, expulsion policies that tend to repatriate herders have been largely seen as reactive and against the human rights protocols of the Economic Community of West African States (ECOWAS) [6]. There have been reported cases of farmers shooting herders whom they blame for the widespread destruction of their crops by cattle (example, The Daily Graphic 10 June 2000; The Ghanaian Chronicle 7 August 2000).

This implies that understanding the factors that lead to the subsequent change in the farming – herding routes will greatly influence effective policies to curb these conflicts and foster unity. Up-to-date information on this is very paramount to understanding the real impact of agricultural land use, ecosystems and other environmental processes [7]. However, throughout the attempts undertaken towards resolving these conflicts, attention has not been drawn to the need to identify factors influencing changing routes in herding [1,7].

The continuous pockets of reported cases of violent conflicts therefore raise numerous rhetorical questions which include the following: What types of relationship fundamentally exist between herders and farmers? Are reported conflicts solely caused by competition for scarce resources; or do they ensue from changes in herding or farming systems, and resource governance regimes? What are the key factors influencing the changing routes of farming – herding boundaries?.

To gain an accurate insight into the above issues and develop cutting-edge strategies to fully address the problem, a holistic approach is urgently needed. This is the motivation for this study because any of these insights requires empirical information regarding the factors that influence the changing routes of herding – farming activities along the study area. Literature on the Fulani herder – farmer relationship in Ghana has only focused on the causes, effects, traditional and/or political dynamics of the conflicts between herders and farmers (e.g Baidoo [8], Alhassan [9], Agyemang [10], Amankwaa [11], Kugbega & Aboagye [12] etc.) without any attention on the important determinants influencing the changing routes of these herders in Ghana which may influence the policy of ending these conflicts.

This implies that there is still a research and knowledge gap especially regarding the factors that influence the movement or changing routes of the herders in Ghana. None of the above stated references have provided any information on these key policy drivers, hence the need for a study. The aim of this study is therefore to examine the factors influencing the movement or changing of herding routes among herders in the North – Eastern corridor of the Northern and Northeast Regions of Ghana. This area serves as an entry point for most of these Fulani herders and therefore serves as an ideal area for exploration in studies of this nature.

This study will help policy makers, NGOs and other campaigners to be more successful in promoting a lasting solution to this natural resource conflict between herders and farmers in Ghana. It will also provide important data and useful insight for future researchers in the area of farmer – herder conflicts and the important factors that affect the changing routes of herders in Ghana.

2. RELATED LITERATURE ON FARMER – HERDER CONFLICTS

Literature on the Fulani herder – farmer relationship in Ghana has sprung up in recent times. This has been attributed to the destruction of crops by cattle belonging to Fulani herders, who are mostly moving from one location to the other to graze their cattle. There has been an increasing trend of both humans and cattle, thereby leading to intense pressure for land to cultivate food crops and graze cattle [13,14].

During the 1960s, the intense competition for natural resources including crop lands and grazing lands resulted in conflicts between pastoralists such as Fulani herdsmen and sedentary indigenous farmers in the Sahel regions of Nigeria, Mali, Niger and parts of Cote d'Ivoire. These conflicts have compelled herders to relocate with their herds to the savannah and transitional agro-ecologies of Ghana and other countries south of the Sahel [15].

Since the arrival of Fulani herders into different parts of the country, there have been pockets of reported conflicts between herders and farmers in the country. This has drawn a lot_of research attention into famer - herder relationships and /or conflicts with diverse focuses.

For instance, Mensah et al. [16] investigated the governing interests of Fulani Herdsmen and Peasant Farmers in Natural Resources in the Akim North District of Ghana. Through focus group discussion with major stake-holders, it was revealed that conflicting interests among stakeholders are the leading causes of violent conflicts between herdsmen and peasant farmers. This, they recommend a consented effort to create equal opportunity to address concerns and pave the way for peaceful coexistence.

In a related study, Baidoo [7] undertook a qualitative study through unstructured interviews with farmers and other stage holders about Farmer-Herder Conflicts in the Agogo Traditional Area of the Ashanti Region and reported that conflicts emanate from the allocation of land by chiefs to herders without consulting local farming communities. A consultative approach to land allocation has been recommended in the study as a way of resolving the problems.

Also, Boateng [3] analysed farmer-herder conflicts in the Asante-Akim North District of Ghana through observation, survey questionnaire and key informant interviews. Competition over the use of land and water resources leading to crop destruction, pollution of drinkable water, rape, killing and maiming of natives were identified as the main causes of conflicts between farmers and herders, and hence compensation packages for affected individuals were recommended in the study.

In the study of Soeters et al. [17] on Agricultural Investments and Farmer-Fulani Pastoralist Conflict in West African Dry lands, undermined chief authority, mistrust within communities, difficulty on the part of Fulani pastoralists to access pasture and water, increased conflict and violence between farmers and pastoralists, hence, a synergized sedentary farming – pastoral model should be put in place to prevent the volatile farmer – herder relationship.

Imoro [5] also undertook a study dubbed 'The Fulani Herdsmen Crisis in West Africa: The Case of Agogo Area in the Asante-Akim North District, Ashanti Region of Ghana'. Through key informant interviews with stakeholders, it was concluded that' ECOWAS free movement policy, pull and push factors, which includes climatic conditions, greener pastures, and security

among others cause the migration of Fulani herdsmen to West Africa. The study recommended that inter-ministerial committees and subcommittees should be setup to regulate nomadic activities while efforts are made to disarm Fulani herdsmen to prevent crimes.

To conclude the literature on farmer – herder related conflicts in Ghana, Dary et al. [4] studied the Triggers of Farmer-Herder Conflicts in Ghana through a Non-Parametric Analysis of Stakeholders' Perspectives using focus group discussions and identified about fourteen triggers of the conflicts as opined by the stakeholders, with destruction of crops by cattle ranking as the most important trigger to the conflicts. An integrated approach was recommended as a way of ensuring effective resolution to these conflicts.

In the nutshell, there is ignited research interest to studies that are designed towards farmer – herder conflicts in recent times due to the escalation of these conflicts in the country. Proper resolution measures are still not in place due to the multi-dimensional nature of the factors attributed to these conflicts. Expulsion calls have not been heeded due to the ECOWAS free movement policy. Integrated approach and proper documentation of the activities of herders and farmers is probably the way to approach this problem and factors influencing herders changing routes is vital to this documentation.

2.1 Empirical Econometric Models of Herder Related Studies

Studies related to influencing factors of herding and herder related studies could best be appreciated when econometric approaches are applied to study these factors. This will pave way for recommended policies to address the significant factors. Related studies have utilized varied econometric models in research related to herding and cattle businesses.

Recently in Kenya, Wafula et al. [18] adopted the logistic regression model to study the determinants of migration and settlement of pastoralists in Kenya city. Their results revealed that pasture and water resources, education and alternative markets are key determinants to migration and settlement. They recommended a policy and regulatory interventions to recognize pastoralism and other forms of farming.

Similarly, Ruhangawebare [19] utilized the Tobit Regression Model to study the factors influencing the level of commercialization among cattle keepers in the pastoral areas of Uganda. Key significant factors influencing sales rates include sex of household head, distance to the nearest livestock market, access to market information, among others. The study recommends access to market information and an upgrade of physical infrastructure.

Hajipuor et al. [20] analysed the factors influencing the movement calendar by using factor analysis (principle component analysis) and KMO statistics. They reported that lack of forage in the winter rangelands and increased annoying insects were effective in early migration of nomads, whereas livestock weight loss and lack of places in the winter rangelands were effective in early and late exit of livestock from the summer rangeland.

3. STUDY AREA AND METHODOLOGY

3.1 The Study Area

The study was conducted along selected communities across the north-eastern corridor of the northern part of the country where there are notable activities of herders. The study targeted the Northeast and Northern regions of Ghana. This area of the country lies eastward to Burkina Faso with most of the communities selected for this study lying close to the Volta Rivers (White and Black). Most Fulani herders prefer this part of the country due to the proximity to rivers and streams that serve as water sources for the animals. The heavy and dark coloured savannah ochrosol soils, Savannah Glysols and the ground water laterite of the eastern corridor of the ocean part of Ghana makes it ideal for the growth of many crops including grasses that serve as fodder for animals [21]. This explains why most animal herders prefer to live in communities around this area. The entire area of the corridor is said to begin from the Tema municipal through the regions of Volta – North, Savanna, North – East and ends at Kulungugu in the Upper East region [22]. Apart from Burkina Faso, the corridor also borders externally to Togo and districts to the western corridors of the country [21]. The map of the eastern corridor of the country is presented in Fig. 1 with the selected districts indicated in the map.

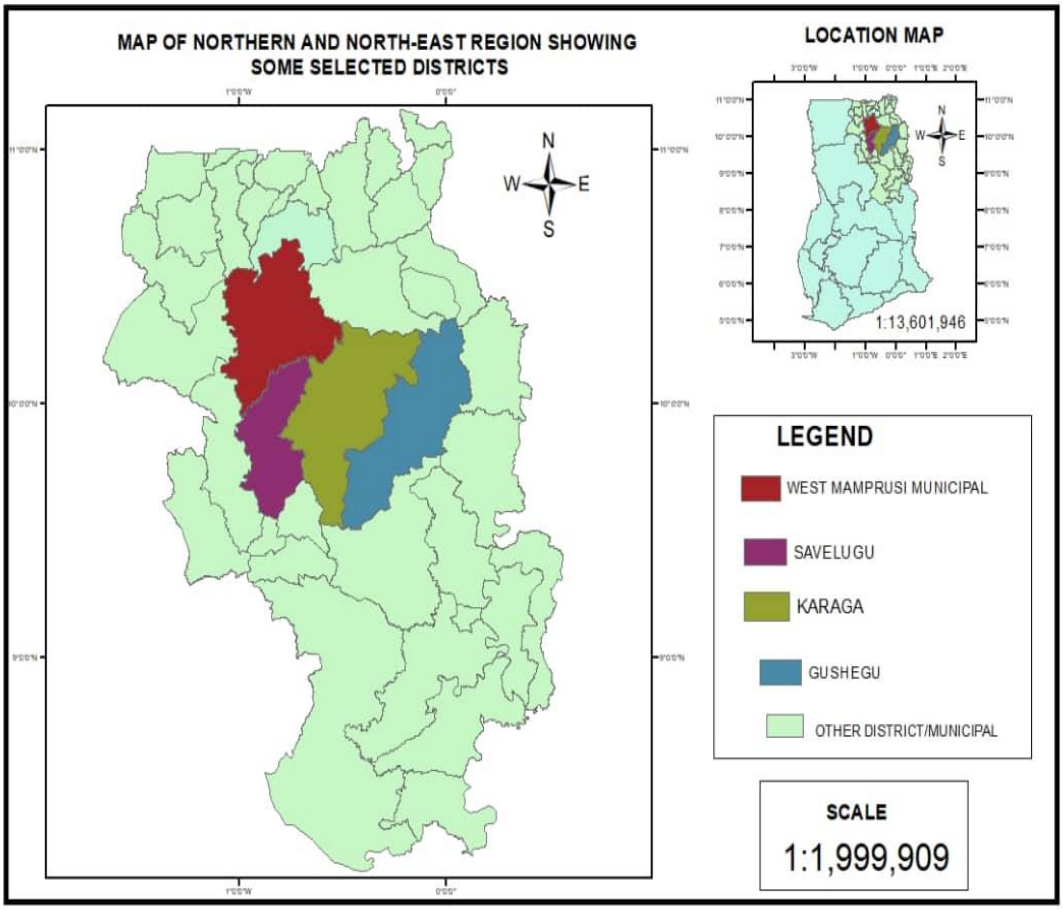

Fig. 1. Map of the study Districts marked out in a Map of the Eastern Corridor
(Source: Authors' Construction, 2022)

3.2 Conceptual Framework and Empirical Models

3.2.1 Conceptual framework

3.2.1.1 Data collection and analysis

Primary data (socioeconomic data) was collected from the herders of these selected districts and communities to help model the factors accounting for changing boundaries and routes of the herders. Primary data was collected from 29th May, 2021 to 2nd February, 2022. In all, about seven communities from four districts were sampled for the study. In each selected district, records of communities that have Fulani herders living there were also selected by purpose. Subsequently, simple random sampling was used to select Fulani herders for the interview. A total of 210 herders and seven opinion leaders were interviewed to obtain data and relevant information for the study. To assess the factors contributing to changing boundaries and/or routes, the number of times a herder has moved from one location to the other since arriving in the country was determined. After testing for appropriateness, a Negative Binomial Model for modeling count outcomes was adopted to determine the factors influencing the changing routes and boundaries of herders after settling in one area.

The collected data were extracted and cleaned in SPSS (version 26) whereas econometric models were estimated in STATA (version 15).

3.3 Conceptual Framework and Empirical Models

3.3.1 Conceptual framework

In this study, we conceptualized the changing routes of Fulani herders to constitute several factors that could be categorized into four main

groups. Embedded in these factors are issues of pull and push factors, which are regarded as either driving away herders from one location to another in the case of push or those factors that invite herders to a new area. It is the belief that the cultural background and demographic characteristics of the herders may influence their desired movement to other areas to graze their cattle. Traditionally, herders from the Sahelian countries regard the movement of herds to long distances and subsequent settling in new areas as part of the occupation of herding. This is further strengthened by the promulgation and ratification of the ECOWAS Treaty on Transhumance Protocol which allows for herders from the Sahel regions to access grazing lands in the littoral states of West Africa [23]. However, after settling in an area, age of respondents, family structure, access to social amenities, climate/environmental change and social relations with natives and/or farmers in an old location could influence changing herding routes or otherwise.

Environmental factors such as availability or otherwise of grazing land for cattle, climatic conditions, water accessibility could have an effect on the decisions of herders towards relocation or otherwise. Environmental factors also have either direct or indirect effects on the political and socioeconomic conditions of a location and this may, intend influence social relations, that may trigger expulsions of herders from one community, forcing them to relocate.

Socioeconomic factors including herd size, herding type, herding purpose, income level, market accessibility, transborder movement to engage in the cattle business may also have an influence on herders' decision to move and subsequent change in herding routes in Ghana. Herders with better economic standing may choose to remain in the current community without any intention of moving to another community. Herders with many cattle, which in most cases are from other owners, may not also have intentions of changing their herding routes. These herders may trek several distances to graze their animals and return to their current locations.

However, these multidimensional factors of migration and/or changing of routes of herding among Fulani herders is mediated by hospitality of natives and/or farmers, law enforcement and respect for the authorities of host communities [24]. A summary of the conceptual underpinning the changing of herding routes is presented in Fig. 2.

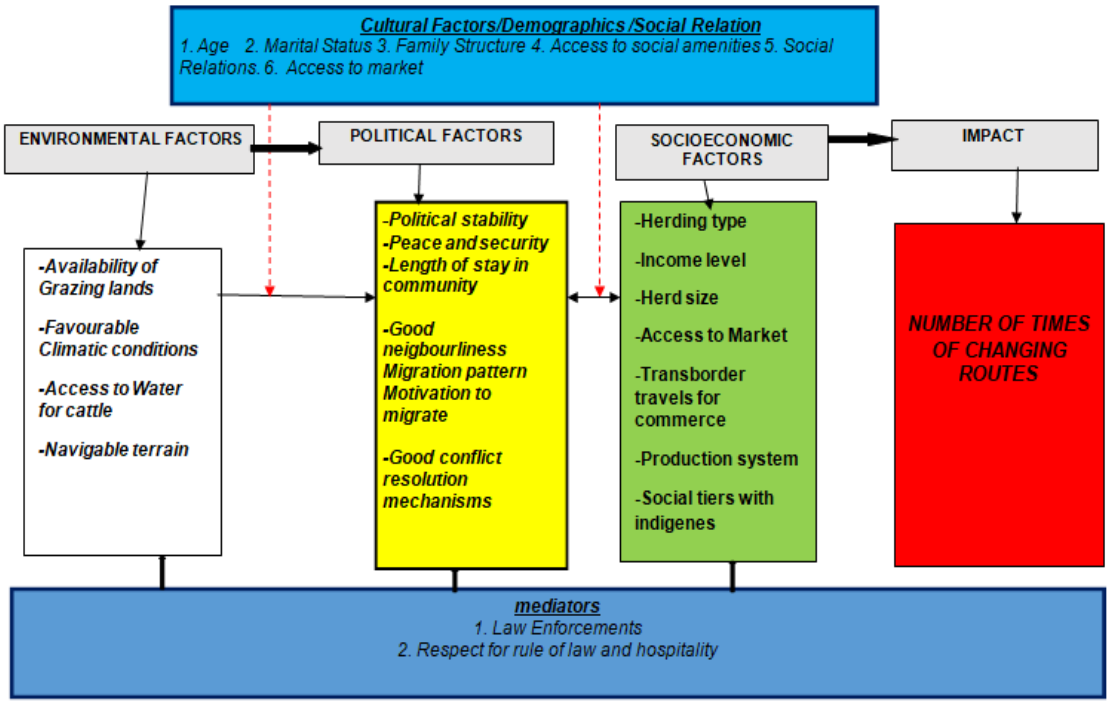

Fig. 2. Conceptual framework
(Source: Authors' Construction, 2022)

3.3.2 Model Specifications and Variables Definition

3.3.2.1 Negative binomial model

The Negative Binomial model was adopted to analyse the data on factors that influence the changing routes of herding. A herder's decision to change herding route is represented by the number of times a herder has relocated since arriving in Ghana. The number of times a herder has relocated or changed route are discrete events and can best be modeled through a count modeling framework [25]. In that case, since the number of times a herder has changed route or relocated is a count, the Poisson regression model, which assumes equi-dispersion of the dependent variable, is usually used [26]. This implies that the distribution of the count variable should have variance (var) being equal to the mean (μ) of the distribution i.e. var(y) = μ [27]. However, formal tests proved that the equi-dispersion assumption was violated in the distribution of the number of times a herder has changed route or relocated. This means that the Poisson model was not appropriate for modelling this count-dependent variable. The distribution of the discrete variables showed evidence of over – dispersion and therefore the Negative Binomial model, which relaxes the assumption of equi-dispersion, replaces the Poisson model to estimate the determinants of changing routes among the Fulani herders of the study area [25]. In over – dispersed data, the Negative Binomial model, which also estimates the parameter (α) of over – dispersion, is appropriate [28]. The restrictive assumption of the Poisson model is relaxed in the case of the Negative Binomial and, for that matter, since the variance is not equal to the mean, following Mutonyi [25], the variance can be given as;

$$\delta\,(y/x) = \mu + \alpha\mu^2 \quad (1)$$

where; δ = the variance, μ = mean and α = over dispersion parameter. The probability that a herder relocates a number of times, X is then specified as;

$$P(X = x/p,r) = \left(r + \frac{x}{x} - 1\right) p^r(1-p)x, \quad (2)$$

where r = failure to relocate or change route, x = the number of times a herder has change routes or relocated to another area since arriving in the country. The covariates for this model are defined and described in the preceding paragraphs of this study.

3.3.2.2 Description of variables, measures and a prior expectations

In this study, several variables were measured but key among them were those that could influence the decision and the number of times a herder relocated. The age of the herders was measured as the absolute number of years a herder had since his/her last date of birth. This variable is important because herding and, for that matter, moving from one location to the other may require some considerable energy and young herdsmen could have more tendency to change herding routes than aged herders. Our *a* prior expectation is that increasing age may reduce the number of times a herder will change location and subsequently herding routes. This variable was logged – transformed to facilitate results interpretation. Marital status was measured as a dummy with a follow up question on the number of wives a herder was having, since this could influence the family size and the ease with which a herder could decide to relocate or change route. We expect that polygamous herders may tend to have more children and may not have the incentive to relocate many times. The number of wives was also logged – transformed.

The number of dependents was measured as the number of people that were directly under the care of a herder for basic necessities. This variable has a bidirectional *a* prior expectation and could influence changing routes either positively or negatively. The nature or type of herding of a herder was also measured as a dummy to determine whether a herder was sedentary or a nomadic herder. A nomad is often changing routes and it is expected that herders that are nomads are likely to relocate frequently than those that are sedentary.

The status of herding is hypothesized to influence the level at which a herder changes routes or location from one location to the other. A herder by status in this study, is whether a hired herder of someone cattle or is a herder to his own cattle. This variable may have positive or negative influence on the number of times that a herder can change route or move from one location to the other. Education is important in decision making and this could influence the number of times a herder could change routes or relocate to another place after staying in one location. This variable was measured as the number of years a herder has obtained formal education. This variable could have negative or

positive influence on the nature of route changing among Fulani herders in the study area.

Household size and number of children a herder have in schools around the country are two variables that may likely influence the decision of herders to change routes or relocate to another area. Household size and children in school will a prior decrease the decision and frequency of changing or relocating to another place after settling at a current location. The duration of stay was also determined as the number of months a herder have lived in a community since settling in that community. It is expected that the longer a herder has stayed in a community, the more the herder builds relationship with farmers and leaders and may not have the desire to change route or relocate to new areas.

Herd size was measured as the number of animals that a herder was herding in a community. It is expected that higher herd size could either motivate or demotivate the changing routes or number of times of relocating to new areas. The herders were asked to indicate whether they have asked community leaders to give them permission to stay at their current location or not. Range was a variable designed to capture information of whether cattle herders are restricted to a certain range within the community to house their cattle and graze them around or whether they are at liberty to house and graze their cattle in any part of the community.

As part of the factors that are necessary for a conducive stay in a location, certain questions pertaining to what is likely to influence a herder to move from a current location to another were posed to the herders. Grazing land was designed to find out whether restriction or unavailability of space for grazing is a major determiner to their decision to change the route. This is expected to be positive. Climate was a variable designed to capture whether herders will move out from a current location if the climate is not favourable to meet a proper stay and survival of cattle in their current location.

In a settlement, the accessibility to some social amenities and social services could influence their decision to change route or location. In relation to this, some of these services were presented to the herders to indicate whether they have access to those services or not. Accessibility was indicated as one or otherwise zero. These services include access to education, access to water, access to health services and access to the market.

The herders were expected to indicate to the enumerators whether there has been an instance where they lost some cattle due to conflict or hostile relationship they had with community members or farmers. The variable was coded as one for if there have been such losses before and zero if otherwise. In line with that, the herders were further asked to indicate if they have ever suffered any damage to property as a result of any quarrel or conflict they had with community members or farmers before. If the option was yes, a value of one was indicated otherwise zero. More often, conflicts, especially of farmer – herder origin is commonly characterized by physical assaults and harm that at times even leads to death. They are therefore required to indicate if they have ever been physically harmed or if they have ever witnessed such instances among their colleagues before. Otherwise, they were to indicate a value of zero for no. Table 1 provides a summary of the variables that were measured in this study and their a priori expectations.

4. RESULTS PRESENTATION AND DISCUSSION

4.1 Descriptive Statistics of Variables

Descriptive statistics of variables featured in the analysis of factors influencing the change in location of herders (herding routes) are presented in Table 1. The average age of the herders is 44.9 years in a range of 18 – 81 years. Polygamy is a common feature of herders and this may influence the family size and the ability of a herder to change location. The study reveals that on average a herder in this current study has almost two wives (1.552) although some of them have no wives, whilst others have a maximum of eight wives. Typical of the African tradition, the average number of persons depending on a herder is almost 11 (10.995). These people may either be relatives living with herders in Ghana or in the herder's native country. Herders practice two main types of herding (Sedentary or Nomadic) and this study reveals that about 96% of the herders were sedentary herders and lives in the communities that this data was collected, whereas 4% were nomadic herders temporally settling in these communities. In an interview with opinion leaders, they indicated that the nomadic herders are those that pose problems through their

herding activities. They claimed that these nomadic herders graze their cattle throughout the night and sometimes allow or lead them to farmers' crop fields to graze. About 59.5% of the herders in this study were herding cattle that belong to natives of communities where they reside, whilst 39.5% were herding their own cattle.

A very low average years (0.395) of education was recorded among the herders in this study. An average of almost 11 (10.895) household members were recorded among the herders.

On average, a herder had about three (2.833) children attending school in Ghana. This is important because it is likely to influence the rate at which a herder may change route or location. A herder had an average of about 17 months of stay in a community with a range of 1 – 70 months recorded. The average herd size of cattle was about 99 in a range of 5 – 2000 animals per herd. The annual income of the herders was GHS36649.38 in a range of GHS110 – GHS500000. This was income from all members of the household which may be accrued from the sale of live animals and other products from these animals. About 97.1% of the herders admitted going through formal processes to obtain permission from community leaders to settle at their current locations, although very few herders (2.9%) alluded that, they did not obtain permission to stay. Obtaining official permission to stay in a community was likely to promote social relationships between herders and community members and prevent conflicts. About 2.9% of the herders indicated that they have been given a range of land in the community to house or ranch their cattle, although majority of the herders (97.1%) of them claimed they could kraal their animals in any part of the community.

As part of the most compelling reasons that could force a herder to change a herding route, about 47.6% of the herders indicated that, lack of grazing land in a current location may force them to relocate to other areas, although majority of the herders (52.4%) indicated that they will rather trek with cattle to other areas to graze their cattle and return to their current location. Again, 36.2% of the herders indicated that an adverse climate is likely to force their change of location from where they were currently staying, although most (63.8) of the herders believe that moving around and coming back to the same location is better and is what they would rather consider.

Table 1. Description, measurement and *a* priori expectation of explanatory variables

Variable	Measurement	*A priori* Expectation
ln Age	Natural log of age of herders in years	-
lnNoWives	Natural log of number of wives a herder is married to	-
lnDependents	Natural log of number of dependents a herder has	+/-
HerdType	1= Sedentary, 0= Nomadic	+/-
HiredHerding	1 = Hired herder, 0 = Owner herder	+
EDUY	Formal education in years	+
HHSize	Number of people in a household	+/-
SchChildren	Number of children in Ghanaian schools	-
Stayduration	Duration of stay in the community in months	+
lnHerdSize	Natural log of Number of cattle	+/-
lnIncome	Natural log of household Annual income in GHS	-
Permission	1=yes, 0=no	-
Range	1=yes, 0=no	-
GrazingLand	1=yes, 0=no	+
Climate	yes = 1, no = 0	+/-
EducAccess	yes = 1, no = 0	+
WaAccess	yes = 1, no = 0	+
LostCattleBefore	yes = 1, no = 0	+
DamageConflict	yes = 1, no = 0	+

Source: Authors' construction, 2022

Table 2. Descriptive statistics of explanatory variables

Variable	Mean	Min	Max	Std.	SE.	Skewness	Kurtosis
Age	44.819	18	81	12.009	0.828	0.468	3.324
NoWives	1.552	0	8	0.806	0.056	2.957	21.381
Dependents	10.995	0	100	9.099	0.628	5.109	45.946
HerdType	0.957	0	1	0.203	0.014	-4.514	21.378
HiredHerding	0.595	0	1	0.492	0.034	-0.3881	1.150
EDUY	0.395	0	12	1.711	0.118	4.8716	27.693
HHSize	10.895	2	80	7.420	0.512	4.399	37.865
SchChildren	2.833	0	70	5.598	0.386	8.547	100.288
Stayduration	17.104	1	70	10.744	0.741	1.249	6.015
HerdSize	99.381	5	2000	159.854	11.03	8.727	98.273
Annual Income	36649.38	110	500000	350698.9	24200.52	13.644	192.962
Permission	0.971	0	1	0.167	0.012	-5.659	33.029
Range	0.029	0	1	0.167	0.012	5.659	33.029
GrazingLand	0.476	0	1	0.501	0.035	0.095	1.009
Climate	0.362	0	1	0.482	0.033	0.575	1.330
EducAccess	0.295	0	1	0.457	0.032	0.898	1.806
WaAccess	0.895	0	1	0.307	0.021	-2.581	7.662
LostCattleBefore	0.086	0	1	0.281	0.019	2.959	9.760
DamageConflict	0.51	0	1	1.728	0.119	-0.925	1.961

Source: Authors' calculation, 2022

The study also sought to find out whether the herders have access to basic facilities in the communities. From Table 1, about 29.5% of the herders indicated that they do not have access to education for their children, although 70.5% of them admitted having access to education for their children. Also, an overwhelming number (89.5%) of the herders indicated that they do not have access to portable water for their domestic consumption.

In conflict related matters, very few herders (8.6%) indicated ever losing some cattle as a result of a misunderstanding or conflict with crop farmers or natives in the communities, although majority (91.4%) have not experienced such losses in the past. Besides, about 51% of the herders indicated either being harmed or suffering damage to properties or witnessing such incidences to a colleague herder. The intensity of these issues may compel herders to relocate or change routes. The results of the summary descriptive statistics are presented in Table 2.

4.2 Poisson Distribution and Test for Equi-dispersion of Number of Times a Herder has changed Location

In this study, the number of times a herder has changed location since arriving in this country as a herder is used as a proxy for changing herding routes. This variable is a count and the number of times a herder has moved from one location to the other can be counted. From Fig. 3 the plot indicates that the variable exhibits a poison distribution, typical of count data and should be measured as such. In studies related to counting dependent variables such as the number of times a herder has changed location or route since arriving in the country, the appropriate empirical model for such analysis is either the Poison regression or Negative Binomial regression and their extensions [29]. Fig. 3 shows the distribution of the number of times herders have changed location since arriving in the country.

After plotting the count variable, the number of timers a herder has changed location or route, we needed to choose between the appropriate econometric model to fit the data. To diagnose the data for equi-dispersion in order to decide between Poisson and Negative Binomial, we first analysed the summary statistics of the Number of Times of location Change variable. As seen in Table 3, the variance (2.19) is about 3 times higher than its mean value (0.64). This means that the distribution shows symptoms of over dispersion, thereby implying that a Poisson model may not be appropriate for this dependent variable.

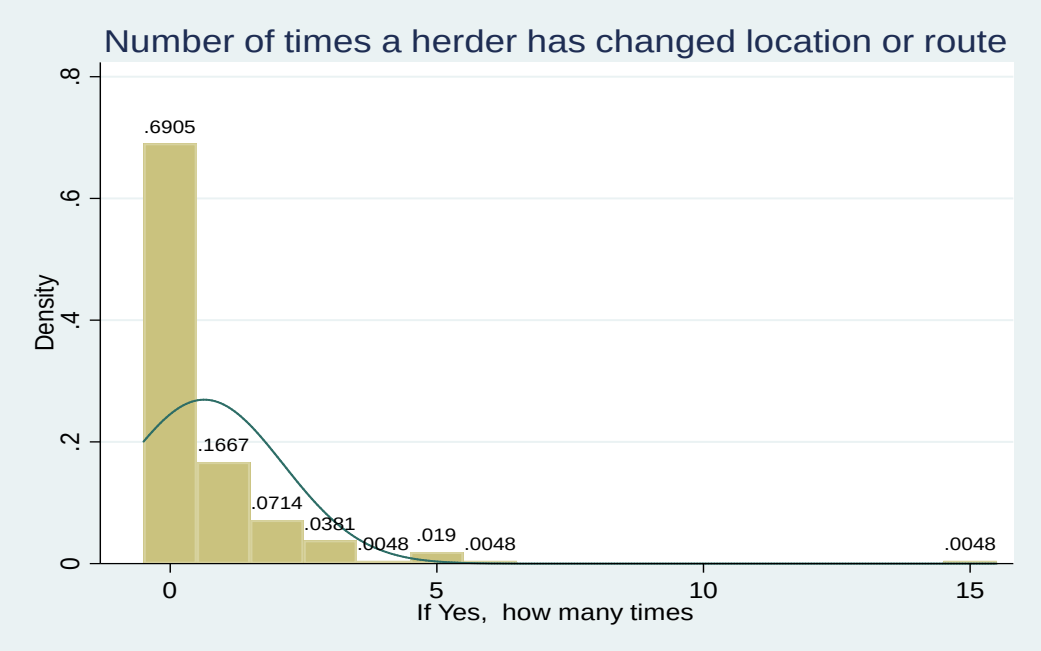

Fig. 3. Poisson distribution of Number of Times Herders change routes
Source: (Authors' Construction, 2022)

Table 3. Summary of Number of Times of relocation of Herders and Test for Equi-dispersion

Descriptive Statistics						
Mean	0.6380952					
Std. Dev.	1.481134					
Variance	2.193757					
Skewness	5.30463					
Kurtosis	45.22555					
Ystar	***Coef.***	***Std. Err.***	***T***	***P>t***	***[95% Conf. Interval]***	
Uhat	***1.902998***	***0.3730507***	***5.10***	***0.000***	***1.167574***	***2.638423***

Deviance goodness-of-fit = 201.4971 Prob > chi2(189) = 0.2536, Pearson goodness-of-fit = 265.9434, Prob > chi2(189) = 0.0002 (Source: Authors' Computation, 2022)

We further confirmed the presence of over dispersion in the count of the number of times herders have changed route by running a regression with ystar and uhat generated from the Times location C variable and the outcome revealed a significant over dispersion of the dependent variable conditional on the covariates (P > |t| = 0.000). The higher value of the Pearson goodness of fit value (265.9434) of the Poisson, further testifies that there is over dispersion in the dependent variable and therefore the Poisson Model may not be appropriate for the analysis, hence the need to apply the negative binomial model to analyse the factors influencing the change in location or herding routes among the herders. The results of the diagnoses test for equi-dispersion are presented in Table 3.

4.3 Factors Affecting Herder Movement from one Location to the other (Changing of Herding Routes)

Based on the results of the analysis of the nature of dispersion of the data, the Poisson and Negative Binomial models were fitted to study the factors influencing the change in location or herding routes of the herders. The marginal effects of the Negative Binomial model were also estimated to facilitate explanation of the results.

The Poisson model was first estimated before the diagnosis of equi-dispersion in the dependent variable. Evidence from the Poisson estimates indicate that about 14 of the covariates significantly influence the number of times a herder changes location or route since arriving in the country.

Table 4. Factors Affecting Herder Movement from one Location to the other (Changing of Herding Routes)

Variables	Poisson	Negative Binomial	Mfx
lnAge	0.329	0.326	0.105
	(0.394)	(0.454)	(0.147)
lnNoWives	0.528*	0.256	0.0827
	(0.270)	(0.340)	(0.110)
lnDependents	-0.522*	-0.402	-0.130
	(0.287)	(0.338)	(0.109)
HerdType	-1.298***	-1.153**	-0.667
	(0.407)	(0.488)	(0.459)
HiredHerding	0.956***	0.866***	0.266***
	(0.252)	(0.297)	(0.0888)
EDUY	0.115***	0.130**	0.0421**
	(0.0410)	(0.0562)	(0.0182)
HHSize	0.0401	0.0376	0.0122
	(0.0338)	(0.0395)	(0.0127)
SchChildren	-0.0530	-0.0489	-0.0158
	(0.0434)	(0.0477)	(0.0153)
Stayduration	-0.0494***	-0.0524***	-0.0170***
	(0.0140)	(0.0161)	(0.00515)
lnHerdSize	0.177	0.178	0.0576
	(0.142)	(0.174)	(0.0562)
lnIncome	0.114**	0.119	0.0386
	(0.0562)	(0.0730)	(0.0240)
Permission	0.380	0.173	0.0516
	(0.453)	(0.561)	(0.155)
Range	-1.266**	-1.178	-0.232***
	(0.609)	(0.727)	(0.0833)
GrazingLand	0.768**	0.729*	0.245*
	(0.352)	(0.398)	(0.141)
Climate	0.518	0.568	0.201
	(0.436)	(0.473)	(0.185)
EducAccess	-0.822**	-0.733	-0.209*
	(0.409)	(0.459)	(0.118)
WaAccess	-0.677*	-0.674	-0.290
	(0.368)	(0.420)	(0.234)
CattleWSource	1.133***	0.947***	0.391**
	(0.265)	(0.317)	(0.167)
LostCattleBefore	-1.703***	-1.762***	-0.312***
	(0.471)	(0.523)	(0.0579)
DamageConflict	-0.270***	-0.273***	-0.0883***
	(0.0637)	(0.0764)	(0.0255)
Constant	-1.022	-0.984	
	(1.556)	(1.840)	

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, LR test of alpha=0: chibar2(01) = 6.64 Prob >= chibar2 = 0.005 LR chi2(20) = 89.51 Prob > chi2 = 0.0000 Log likelihood = -176.70018 Pseudo R2 = 0.2021*
(Source: Authors' Computation, 2022)

The Negative Binomial model was also estimated following a rejection of the null hypothesis of equi-dispersion. From the results, the chi2 value (LR chi2(20) = 89.51 Prob > chi2 = 0.0000) indicates that the selected variables jointly explained the variation in the number of times a herder has changed route. The Pseudo R2 = 0.2021 also implies that the model accounted for about 20.21% of the variation in the number of times a herder changes location or routes after settling at one particular location. The LR test of alpha=0 estimated alongside the Negative Binomial (chibar2(01) = 6.64 Prob >= chibar2 = 0.005) shows evidence of overdispersion in the

dependent variable and the justification for the application of the Negative Binomial to analyse the factors that influence the number of times a herder will change route.

With reference to Table 4, the Negative Binomial output indicates that HerdType significantly (P≤0.05) influences the number of times herder changed location or route after an initial arrival in the country. The results indicate that being a sedentary herder reduces the number of times of changing location or route relative to being a nomadic herder ceteris paribus. This is probably because of better relationships herders might have established with farmers and community members and may not feel moving or changing route.

Other variables such as Hired Herding, EDUY, Stay Duration, Income, Grazing land, Cattle Water Source and Damage due to Conflict all statistically influence the number of times herders change location or route under the Negative Binomial regression model in various directions and at conventional levels of significance. To effectively determine the magnitude of the influence of each of the factors, we estimated the marginal effects generated from the Negative Binomial model. The discussion therefore dwells more on the marginal effects of the independent variables of this model presented in Table 4.

From Table 4, Hired Herding is statistically significant (P≤0.01) and indicates that herders who are hired to herd cattle that belong to others are likely to change location to about 26.6% times, all things being equal. This means that hired herders may migrate several times to other areas, probably to be able to increase the herd size and increase their share of animals in the herd. Also, one percentage change in the years of education of a herder significantly (P≤0.05) increases the number of times a herder changes route by 4.21% ceteris paribus. This implies that educated herders have more tendency to change herding routes than those that are not educated and this may be attributed to their knowledge of the effect of overgrazing at one locality. Again, a percentage change in the number of months a herder has stayed in a community ceteris paribus, significantly (P≤0.01) decreases the number of times a herder changes location by 1.7%. The implication is that, the more the number of months a herder has stayed in a community, the less likely the herder to move to another location or route, probably due to relationships established between Fulani herders and farmers or community members for that matter. Evidence from the results in Table 4 also provides an indication that herders who are offered a range of grazing and/or kraaling land have significantly (P≤0.01) about 23.2% decreased number of times of relocation or change in herding route. Herders who reported that lack of grazing land for their cattle in a current location will influence their relocation to new location are more likely to significantly (P≤0.10) increase the number of times they change route by 24.5% holding other factors constant. The EducAccess variable is statistically (P≤0.10) significant and implies that herders who indicate having access to education for their family are more likely to have about 20.9% decreased number of times of changing route or location from their current location ceteris paribus.

The results also reveal that unavailability of water for cattle or if cattle do not have a reliable water source, the number of times of moving to a new location or changing routes increases statistically (P≤0.05) by 39.1%, all things being equal. Contrary to aprior expectations, herders who admitted losing cattle before due to misunderstanding or conflict significantly (P≤0.05) have about a 31.2%-point reduction in the number of times they change route or location, if other factors are fixed. This probably implies that community members and/or farmers always take responsibility and repay for losses after an amicable resolution. Besides that, herders with a history of suffering from any form of damage or witnessing the same, significantly (P≤0.05) reduce the number of counts in changing route by about 8.83% if other things are held constant. This could also be attributed to effective conflict resolution between herders and community members, especially judging from the fact that most (59.5%) of the herders were herding cattle that belong to community members. Table 4 presents the results of the Poisson, Negative Binomial Models and the Marginal effects of factors influencing changing routes of the herders.

5. CONCLUSION AND POLICY RECOMMENDATION

5.1 Conclusion

The study reveals that, on average, the herders are within the active working class, with a low

level of education and with high dependents, averaging almost 11 dependents per herder. The majority of the herders featured in this study were sedentary herders, with most of them herding cattle that either belong to community members or other cattle owners from their native countries or other parts of the country. Household members were also high among the herders and an average of about two children of these herders were attending schools in Ghana.

The study found that each of the Fulani herders has lived in their respective communities for almost two years with an average herd size of 99 animals. It was also established that most of the herders have formally been given permission by the authorities to stay in their respective communities.

Duration of a herder's stay in a community, being given a range for kraaling or grazing, having access to education for children, losing cattle before and ever being harmed or witnessing the same due to conflict are important factors that prevent or reduce the number of times a herder changes location or route. On the other hand, factors including hired herding, years of education of a herder, restriction or lack of grazing land for cattle and lack of access to water for herders are some of the most compelling factors that lead to changes in location or herding routes of Fulani herders.

5.2 Policy Recommendation

From the findings of this study, the following are recommended for policy makers who may have an interest in tackling farmer-herder conflicts due to changes in location or herding routes among herders:

1. Efforts should be made to register Fulani herders and integrate them into the various communities whilst encouraging them to educate their children.
2. Community leaders should endeavour to allocate land to Fulani herders found in their communities for kraaling and/or grazing to encourage them to have permanent staying status. This is likely to create a symbiotic relationship where the animals could be ranched on fields during the dry season and fertilize the soil with their dung and graze on crop residues after harvest.
3. Water and other important facilities should be made accessible to herders to enable them to stay in their respective communities and avoid changing herding routes that may lead to other social problems including conflicts and crimes.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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