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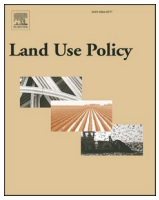

# Mapping of community perspectives on land acquisition for biofuel investment in northern Ghana

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ABSTRACT

We apply Q methodology, a model with a qualitative background, albeit with rigorous quantitative analysis, to map community perspectives (concerns, attitudes, beliefs, opinions, and perceptions) towards the acquisition of communal land for a biofuel project in northern Ghana. We extracted four community perspectives, in the order of importance as follows: (1) pro-biofuel project, but pessimistic (2) against the biofuel project (pro-environmental) (3) strong against and (4) optimistic. Taken together, the perspectives suggest the local people believe the biofuel project has no potential to improve their livelihoods, meanwhile, there is a consensus that the project destroyed trees of economic importance and provided poor working conditions for the local employees. We recommend (1) the establishment of enforceable economic and social contracts between the employees, local land users and the biofuel investors (2) direct monetary compensation for the affected communal land users (3) investigation of allegations of late or partial-payment of salaries of the biofuel project's employees (4) future considerations for acquiring communal land should include broad community consultations and incorporate the local land users' interests, concerns, and viewpoints and (5) the local bioenergy policy of the government of Ghana must include checks on communal land sale decisions, which directly or indirectly impact the welfare of the people.

## 1. Introduction

Partly due to economic and environmental concerns, the use of biofuels in place of fossil fuels is increasing worldwide (Ghosh et al., 2023). Large land acquisitions for biofuel development are an issue with rising global interest. The expansion of biofuel, especially, in the African setting, has become a very contentious issue that has attracted the attention of several stakeholders including policy makers, and researchers (Amigun et al., 2011b; Ayamga et al., 2023). The tropical countries, especially in Africa, are generally believed to have a comparative advantage in the commercial production of biofuel feedstock because of the availability of supposedly idle and/or underused lands and the relatively cheap farm labour services (Amigun et al., 2011b; Giovannetti and Ticci, 2016).

Several biofuel development sites have been established in Ghana. The biofuel project by Solar Harvest, formerly called Biofuel Africa, is the largest and most significant in terms of the amount of land acquired and the magnitude of the investment. It is in Yendi Municipality in the northern Region of Ghana. Solar Harvest was the first biofuel firm in Ghana to be granted a permit by the Environmental Protection Agency of Ghana. The company was registered in 2007 and produces upstream jatropha oil. Schoneveld et al. (2011) noted that the proliferation of large-scale land acquisitions in Ghana and their subsequent use for biofuel production most often generated mixed waves of community reactions. Selfa et al. (2011) reported beneficial socioeconomic and environmental outcomes from biofuel developments in Ghana. However, recently, Ayamga et al. (2023) and Sullivan et al. (2023) documented that in Ghana and Tanzania, local households have reduced access to farmlands and worsening economic livelihoods following large-scale land acquisitions by both foreign and domestic investors.

In northern Ghana, land ownership is communal. That is, the land belongs to everyone in the community but is held in trust by the chiefs. The question we ask is: What is the range of perspectives when the land trust holders (chiefs) give out communal land to biofuel developers? Thus, the present study attempts to map the community perspectives (views, attitudes, opinions, perceptions, and concerns) towards the

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acquisition of communal land by Solar Harvest. The goal of this paper is two-fold. First, by offering insights into perspectives about biofuels on communal lands, this study advances knowledge by helping to shape energy policy on communal land decisions. Second, this paper will bring the usefulness of Q methodology to the fore. This unique methodology, which is gaining popularity in economics has qualitative background, albeit with a rigorous quantitative analysis. Q would make it possible to conceptualize and provide rich analyses of the different perspectives held by the persons affected by biofuel development in northern Ghana. Barry and Proops (1999) posit that Q has a promising application in environmental and ecological economics, noting that it is often difficult to explore and accept which environmental policies are socially and politically acceptable. Q can provide a forum or platform to start conversations to identify the divergent and convergent opinions held by various groups of people and come to conclusions and policies that could be deemed socially, economically, and environmentally reasonable.

The rest of the paper is organized as follows. Some relevant literature are reviewed in Section 2. The justification for employing Q methodology for this study is discussed in Section 3. The research design and the theoretical model are described in Section 4. The empirical analyses and the results are presented in Sections 5 and 6 respectively. Section 7 provides a discussion of the results and the limitations of the study. Finally, Section 8 presents the conclusions and recommendations for policy and further research.

## 2. Review of relevant literature

There is some literature currently discussing community and stakeholder perspectives on biofuel expansion in the US (Albatayneh et al., 2019; Ghosh et al., 2023; Gowan and Kar, 2018) and other countries including the EU (Götz et al., 2017,) developing countries (Zhao et al., 2020), South Africa (Amigun et al., 2011a; Nasterlack et al., 2014), and Brazil (Conteratto et al., 2023). These studies documented varieties of stakeholder opinions concerning land acquisitions and biofuels. For Ghana, few studies including German et al. (2011), Ahmed (2021), Dompreh et al. (2021), Ahmed and Gasparatos (2016) investigated the views of local communities and Ghanaian stakeholders involved in the national biofuel industry. Ahmed (2021) discovered that despite current stakeholder pessimism regarding Ghana's biofuel industry prospects—especially concerning jatropha—some interest remains in the crop. Dompreh et al. (2021) found various opinions, but most stakeholders think that financial and market constraints drive adoption. Ahmed and Gasparatos (2016) discovered that there was a discrepancy between the impacts the communities experienced and those considered in environmental impact assessments. Through a perception mapping exercise, they determined that the primary reason for the impact mismatch was the communities' limited participation in the project planning and impact assessment processes.

Our study differs from previous studies on perspectives, both methodologically and contextually. First, previous studies employed descriptive statistics, content and discourse analysis, conventional scale ratings and rank orderings. These are entirely *qualitative* approaches. Q methodology is a relatively more recent approach that provides a rich analysis of perspectives by integrating rigorous quantitative and qualitative means of analysing perspectives as a subjective concept (Brown, 1982). The motivation underlying the use of Q for perspectives analysis results from the fact that the existing *quantitative* approaches in social sciences failed to consider individuals' concerns, the generalised and the shared perspectives (Brown, 1996). Q marks the intersection between quantitative and qualitative techniques in social science research and is useful for exploring complex sets of opinions, perceptions, and values (Müller and Kals, 2004). Among a group of stakeholders, Q attempts to identify a variety of divergent viewpoints and consensus in opinions, as well as the number of people within the group who hold those perspectives.

Second, (Preuss (2012) noted that about 78% of the Ghanaian lands are communal with heterogeneous communal structures. In such a system, although biofuel projects may be economically viable, they may nevertheless, have undesirable social consequences. In southern Ghana, where most of the above studies were conducted, private land ownership is generally the practice, whereas in northern Ghana, the chiefs hold allodial land titles and therefore they have the prerogatives in deciding how the benefits from land deals are utilised (Kasanga and Kotey, 2001). This Q study would assist in understanding the concerns, attitudes, opinions, and perceptions of members of communities where communal lands are acquired for biofuel activities in northern Ghana.

## 3. Justification for using Q methodology

Q Methodology, Q for short, is a relatively new method in economics. The methodology, developed by (Stephenson (1953), a British Physicist-Psychologist, was initially applied in psychological research but has increasingly been applied in other fields of social relevance. Stephenson wanted to study subjectivity in any situation, such as the interpretation of poems and aesthetic appeal (Brown, 1982). Q, which exploits the fundamental theory of factor analysis has since been applied to an array of research topics about environmental policy, including environmental discourse analysis, environmental conflict management, global climate change, animal welfare, forest protection and environmental valuation (Steelman and Maguire, 1999; Barry and Proops, 1999; Dasgupta and Vira, 2005). Recently, Sorola (2022) applied Q to study the perspectives of accountants on social and environmental reporting.

Land acquisitions for biofuel production often affect diverse groups of concerned stakeholders with various typologies of social, environmental, and economic interests. By systematically classifying individuals with common characteristics, Q can identify the people's behaviour toward the biofuel project by carefully analysing the pattern of answers provided across the population. It enables the researcher to unravel shared perspectives and attempts to reconcile dissenting views. Q reveals consensus statements for each group, which, according to (Focht and Lawler (2000), could form the basis for policy discussions and negotiations among groups whose viewpoints are opposed to one another. For example, Cuppen et al. (2010) applied Q to select participants for stakeholder dialogue on biomass energy options in the Netherlands. Q has been credited as best, in principle, for confronting socially disputed, discussed, and debated issues because it delineates areas of agreement and discord and points out shared views and differences in perspectives (Dasgupta and Vira, 2005).

The alternative ways of evaluating perspectives are not as rigorously appealing as Q. The conventional Likert ratings and rank orderings may result in a loss of meaning (McKeown, 2001). Ho (2017) noted that although Likert-type scales are economical and easy to analyse, it can be difficult to interpret or translate the results meaningfully. Q-methodology yields a holistic and in-depth analysis of the prevailing perceptions and attitudes. According to Cross (2005), whereas Q and the other alternative methods are all based on subjectivity, the perspectives extracted in Q are rooted in concretised behaviour and are usually consistent and replicable (Brown, 1982). Q provides a more detailed and nuanced analysis of perspectives rather than mere positive and negative viewpoints ordinarily typical of the alternative survey techniques. Some researchers, for example, Brown (1994) and Zraick and Boone (1991), assert that no other methodology duplicates Q in its versatility in analysing subjectivity, noting that Q is entirely consistent with the principles and theory of contemporary science.

Q is usually compared with R methodology (R factor analysis). Whereas Q is concerned with establishing patterns of responses within

and across individuals, R examines the patterns across individual characteristics such as height, gender, and social class (Barry and Proops, 1999). Q attempts to correlate and classify participants' minds but not to analyse their characteristics.[2] This contrasts R, which aims to analyse human traits, objectively (Steelman and Maguire, 1999). Furthermore, R conventionally employs survey questionnaires in which participants evaluate isolated statements, whereas Q requests participants to articulate their views on each statement relative to all other statements. Unlike R, Q does not seek to calculate population parameters but rather to sample the range and the variety of views expressed. It aims to provide a picture of the latent perspectives but not to make claims about the proportion of participants expressing particular views (Cuppen et al., 2010; Kitzinger, 1987). Q involves a set of theories and procedures that sustain the type of subjectivity research that is classical of qualitative research whilst employing robust quantitative tools (Cross, 2005).

## 4. Q methodology

### 4.1. Overview

The body of theory and principles known as Q methodology encompasses techniques, methods, and explanations. It offers flexible procedures for subjectivity analysis. Q sample, in its most common form, consists of statements of opinion that a person ranks according to a condition of instruction. Q sort is a sample of objects[3] arranged meaningfully by a single person. A Q-sort is the picture of a person's perception of the current situation. It is, therefore, subjective and self-referential (Brown, 1982). Q sorts collected from multiple individuals are typically correlated and factor analysed. Factors show groups of people who essentially ranked the statements similarly. The factors are explained in terms of shared attitudes or perspectives.

### 4.2. Q sampling

During Q sampling, the participants elucidate their viewpoints on an issue of subjective importance. Therefore, a set of objects (typically statements on cards), known as the Q sample is presented to the participants, who are asked to rank the statements according to some instructions. In Q, the term "sample" does not refer to a collection of persons but refers to a set of statements. The set of statements a participant has ranked is called *Q-sort* and the participant is called a *sort*. Administering Q sort involves much more mental activity than administering a questionnaire. Ordinarily, Q sample statements are written on cards or separate sheets of papers. Then, they are numbered, shuffled, and presented to the participants to rank order in a continuum based on their opinions on a given issue. Most commonly, the participants are asked to rank-order the statements on a given Likert-type scale from disagreement to agreement. The ranking may range from − 2 (strongly disagree) to +2 (strongly agree). With the complete set of statements, the participants are asked to examine them collectively and evaluate each statement relative to all the other statements (McKeown, 2001. Cuppen et al. (2010) and Baker et al. (2006) recommend a Q-sort exercise be accompanied by brief interviews where participants explain their sorting to obtain qualitative information useful in interpreting the factors.

Two mutually exclusive Q sort distribution types are in contention: a forced-choice distribution and a free-sort distribution (McKeown and Thomas, 2013). With the forced-choice distribution participants are asked to assign a predetermined number of statements to each strength of agreement. For example, they may be instructed to place six statements under − 2, seven statements under − 1, ten statements under 0, etc. The resulting shape will be a pyramidal, pseudo-normal distribution. That is, the participants are asked to place fewer statements at the tails of the distribution, with an increasing number of statements towards the center.[4] The alternative is free-sort distribution whereby the participants can freely decide the number of statements to place under the different strengths of agreement. However, choosing a Q-sort distribution type for a particular study is inconsequential because Brown (1982) has shown with a varied array of Q-sort distributions, that the distributional effect on the factors resulting from a particular study is zero.

#### 4.2.1. Q sample

The starting point of Q sampling is the establishment of a concourse from which the Q sample could be drawn.[5] The concourse of a Q study may be obtained from the interactions and discussions with relevant stakeholders, key informant interviews, online discussions, newspapers, pictures, and relevant literature, among other sources (Baker et al., 2006). From the concourse of statements, the researcher must decide which statements to include in the Q sample based on their theoretical propositions. The number of statements to include in a Q sample has been debated in the literature. For instance, Cuppen et al. (2010) suppose that the number of statements should not exceed 60, whilst Denzine (1998) argues that for the statements to possess enough statistical reliability, there should be at least 60 statements. Whereas McKeown (2001) suggest that the statements can vary between 30 and 100, Cross (2005) believes the Q sample usually should consist of between 10 and 100 statements. Baker et al. (2006) also noted that the number of statements varies between studies but is usually between 20 and 100. Barry and Proops (1999) considered 36 Q sample statements adequate in an environmental sustainability study, arguing that a Q study is time-consuming. Therefore, the number of statements should be manageable for both the researcher and the participants. Schlinger (1969) proposed that the number of statements should generally not outnumber the participants. However, the consensus is that the Q sample should reflect the diversity of the concourse.

#### 4.2.2. Q participants

In Q, purposive sampling and a few participants have generally been recommended in the literature (see Barry and Proops, 1999; Cross, 2005; Cuppen et al., 2010). According to Denzine (1998) the participants in a Q study need not be representative of the population; rather, the Q statements should be representative of the concourse. Therefore, participants can be selected using non-probability sampling techniques. The principle of large numbers frequently required in social science research to achieve statistical significance is inconsequential in Q. What is relevant is the pattern of subjectivity present and the degree to which they are similar and dissimilar. Ramlo (2005), for example, have used 10 participants for a Q study to examine college faculty perspectives and consensus concerning establishing a technology school. Barry and Proops (1999) conceive that as few as 12 participants can produce statistically significant results.

[2] Conventionally, the "respondents" in a Q study are referred to as "participants". This is because, during the data collection process, they do not only respond to questions, but they are also made to participate actively by sorting out cards of statements, comparing them, and making critical evaluations.

[3] The objects of Q sample could be pictures, photos, statements on cards or any set of objects about which an individual can express their opinion.

[4] The argument for the force-choice, pseudo-normal distribution, is based on the Law of Error in which it is supposed that fewer issues are of immense importance and therefore, the number of statements the participant may strongly agree or disagree with are fewer than issues of less relevance. (McKeown and Thomas, 2013).

[5] Concourse is analogous to a population in an R study. It refers to the entire set of information about the topic under consideration (Baker et al., 2006).

### 4.3. Analysing Q sorts

The analysis of Q sorts is accomplished by the PQ Method software which involves a sequential execution of three sets of statistical procedures including correlation, factor analysis and factor score computation.

### 4.4. Correlation

The first step in analysing Q sorts involves generating a correlation matrix between the Q sorts (rankings by participants) from the raw sorts in which every sort is correlated with every other sort. This generates an $N \times N$ correlation matrix where $N$ is the number of participants in the Q sort exercise. The correlation $\rho$, between any two sorts, is computed as:

$$\rho = 1 - \frac{\sum d^2}{2N\sigma_D^2}; \quad -1 \leq \rho \leq 1 \tag{1}$$

where $\sum d^2$ is the sum of squared differences between the Q sort values for the respective individuals, and $2N\sigma_D^2$, is the variance of the Q sort distribution. The value of $\rho$ between any two Q sorts suggests the extent of the similarities between them.

### 4.5. Factor analysis

Factor analysis seeks to condense multivariate data into a few factors. Factor analysis of Q sorts seeks to evaluate which individuals cluster together to represent a category of opinion, and typically, it involves factor extraction and factor rotation.[6]

#### 4.5.1. Factor rotation

Any two factors representing two perspectives can be depicted in a Cartesian plane so that the participants who constitute these factors are the coordinates. Factor rotation, therefore, refers to the process of manipulating or adjusting the reference axes (X and Y axes) aiming to position them so that they intersect many sorts (data points). Factors are rotated because, typically, most sorts have high loadings[7] on one factor and low loadings on all other factors, i.e. a somewhat overlapping of factors. This characteristic of overlapping factors can confuse the interpretation of factors that will emerge, so the primary reason for rotating factors is to improve the interpretation of the factors. Therefore, after factors have been extracted, they are rotated so that the sorts associated with a particular factor load highly on that factor and, if possible, zero on the other. After rotation, the cluster of persons intersects with the factor with which they are most related. The factor with many loadings is the most important relative to all others. The initial factors extracted contain unrotated factor loadings, whilst the rotated factors contain rotated factor loadings (Brown, 1982; Field, 2013).

There are two alternative types of factor rotation, and the choice of rotation type is contingent on whether there is a plausible theoretical reason to assume that the factors are related or independent. One is orthogonal rotation, which assumes that the underlying factors are uncorrelated. The other option is to perform oblique rotation, also called hand rotation. This is carried out when there is a reasonable theoretical ground to suppose that the underlying factors are correlated (Field, 2013). According to Brard and Lê (2018), the choice of factor rotation method is the researcher's prerogative. However, the varimax procedure frequently uses orthogonal rotation in Q analysis. Varimax procedure attempts to maximise the spread of loadings within factors by loading a fewer number of sorts highly onto each factor. This results in a more interpretable number of factors (Field, 2013; Stenner et al., 2008; Field, 2013).

#### 4.5.2. Factor loadings and flagging of factor loadings

After factor extraction, the significant factor loadings $\tau$ are flagged (marked).[8] Flagging of a factor loading for a Q sort $n$ depends on the sort's share of the communality (common variance), denoted as $h^2$, for the associated factor and the significance level of the factor loading. A squared factor loading $\tau_{nj}^2$ for a Q, sort $n$ on factor $j$ is the percentage of the sort's response associated with factor $j$ or is in common with the other participants' responses in factor $j$. A communality $h^2$ is the sum of squared factor loadings $\sum_{j_1}^{j} \tau_{nj}^2$, of a Q sort $n$ across the factors $j = 1, 2, \cdots J$ (Brown, 1982). It, therefore, represents the proportion of a participant's response that is associated with all factors or is in common with the responses of all the other participants. A low $h^2$ for a participant implies that the participant's response has little in common with the other participants' responses and is, therefore, unique. Flagging of a factor loading $\tau$, of a Q sort $n$, in factor $j$ occurs if:

$$\tau_{nj}^2 > \frac{h^2}{2} \quad \text{where} \quad h^2 = \sum_{j_1}^{j} \tau_{nj}^2 \tag{2}$$

which means factor $j$, containing Q sort $n$, explained the common variance $h^2$ by more than half, and if:

$$\tau_{nj} > \frac{1.96}{\sqrt{N}} \tag{3}$$

which means the factor loading $\tau$ of Q sort $n$, on the $j^{th}$ factor is significant at the 0.05 level.[9]

Any factor in which none of its factor loadings, for all the Q sorts, is flagged is dropped from further analysis because it implies no participant loaded significantly on that factor. It is important to note that only pure Q sorts are flagged before factor rotation.[10] According to Brown (1991), any factor with at least two significant loadings is worth discussing. Persons who have significant positive loadings on a factor share a common perspective. Those with significant negative loadings on the same factor express opposing views.

[6] Although the PQ Method executes factor extraction before factor rotation, it would be conceptually convenient to describe the factor rotation procedure before factor extraction.

[7] Factor loadings can be interpreted as correlation coefficients, which represent the extent to which each Q sort is associated with each factor. If a participant loads very highly on a factor when compared with others, this means that this participant is more representative of that factor (Brown, 1982). The statistical procedure for computing a factor loading is shown by Brown (1982) and it is somewhat complex. Typically, it involves an iterative process. However, the general formula for computing a factor loading for a Q sort $n$, on a factor is $\frac{t_n}{\sqrt{T}}$ where $t = \sum_{n=1}^{N} \rho_g$, the sum of the correlations of all persons, $n = 1, 2, \cdots N$ in column $g$ of the correlation matrix and $T = \sum_{g=1}^{G} t_g$ which is the grand total of the correlations for all columns, $g = 1, 2, \cdots G$. The iterative process derives from the attempt to obtain the appropriate estimate for $t$, which includes the correlation of a Q sort with itself, i.e., a diagonal entry of the correlation matrix. It has been argued that when an individual is instructed to perform a Q sort exercise twice, at two different times, it is unlikely that he or she will correlate with himself or herself up to 1 (100%). Some studies including Brown (1982) have argued that a more realistic value will be in the range of 0.8–0.9, and therefore, it is incorrect to use 1 as a diagonal entry in the inter-correlation matrix. The iterative process therefore seeks to achieve the "self-correlation" value within the range of 0.8–0.9 for inclusion in $t$.

[8] Flagging of factor loadings is the process of identifying the factors to which each participant belongs and it is a precondition for factor rotation.

[9] By a similarly, given $\frac{1}{\sqrt{N}}$ as the standard error of the Q sort distribution, a factor loading, which is greater than $\frac{2.58}{\sqrt{N}}$ is significant at the 0.01 level and $\frac{1.65}{\sqrt{N}}$ at the 0.1 level.

[10] A pure Q sort is one that loads significantly on one and only one factor as against an impure Q sort, which has significant factor loadings on more than one factor.

#### 4.5.3. "Impure" factor loadings

After factor rotation, the generated factor loadings may include "impure" factor loadings. Any Q sort that loads significantly on more than one factor or similarly loads on several factors is impure (Dasgupta and Vira, 2005). Such a sort does not provide a focused point of view and thus has a blend of perspectives. All impure Q sorts are evaluated by persons whose attitudes and opinions are unrelated to any other person because of sampling error or because they are idiosyncratic. That is, they have diverse perspectives and cannot be associated with any of the themes represented by the factors. Therefore, to avoid errors in interpreting results, these Q sorts must be omitted from further analysis (Brown, 1991).

#### 4.5.4. Factor extraction

Factor extraction, performed on the inter-correlation matrix, generates an unrotated factor loadings matrix. Two alternative methods, centroid analysis, and Principal Component Analysis (PCA) may be used to extract factors. Centroid analysis is usually preferred because it allows the researcher to rotate the factors according to his or her theoretical propositions (Field, 2013). The unrotated factors are generated along with their eigenvalues, which represent the amount of the total variation in the Q sort distribution that is explained by each factor. An eigenvalue for factor $j$ is computed as the sum of squared factor loadings of all the Q sorts in that factor.[11] That is

$$\vartheta_j = \sum_{n=1}^{N} \tau_{nj} \tag{4}$$

where $\vartheta_j$ denotes the eigenvalue of factor $j$, $\tau_{nj}$ represents the factor loading for the $n^{th}$ participant on the $j^{th}$ factor and $N$ is the number of participants in the Q sort exercise. Equivalently, an eigenvalue can be expressed as the percentage of the total variation explained by each factor, i.e.

$$\frac{\vartheta_j}{N} 100.$$

The absolute and relative sizes of the eigenvalues have some importance in deciding how many of the extracted factors are significant and, therefore, to be retained for further analysis (Field, 2013). The larger the eigenvalue of factor $j$, the more significant its contribution to explaining the total variance (Kline, 2014). The question of which unrotated factors are significant and, therefore, to be retained has been argued in the literature. Kaiser (1960) suggests that all factors with eigenvalues greater than 1.00 should be included for further analysis, pointing out that an eigenvalue of 1.00 represents an enormous amount of the total explained variation. On the other hand, Jolliffe (1972) argues that Kaiser's criterion is too strict and proposes that all factors with eigenvalues greater than 0.70 should be accepted.

### 4.6. Factor scores

In Q, the relevance of factor loadings is to identify the factors (perspectives) to which each participant belongs or loads significantly. After identifying the factors, the next task is to identify the subset of Q statements associated with each factor. A factor score is a weighted average of the ratings attributed to a Q statement by all the Q sorts associated with the factor type[12] By combining the Q sorts, what is unique to each participant, called specificity, is cancelled out leaving what is common among them. In the weighting process, sort scores of participants with high factor loadings receive more weight because they are more representative of the factor. Brown (1982) states that the formula for computing the factor weights, which is credited to Spearman (1961), is given by:

$$w_{nj} = \frac{\tau_{nj}}{1 - \tau_{nj}^2}$$

where $w_{nj}$ is the factor weight for the $n^{th}$ participant belonging to factor $j$, and $\tau_{nj}$ is the corresponding factor loading. The higher the squared factor loading for a Q sort, $\tau_{nj}^2$, i.e., the higher the proportion of the common response in factor $j$, which is contributed by Q sort $n$, the higher the factor weight $w_{nj}$ received by the sort. Klovan and Imbrie (1971) have shown that the following matrix notation generates the factor scores matrix $F$.

$$W'QA'$$

where $W'$ is a transposed row-normalised data matrix (sum of each row is unity), i.e. each element in $W'$ has unit vector distance, Q is a principal factor-loadings matrix, which serves as the weighting matrix that contains the factor weights $w_{nj}$, and A' is a transposed diagonal matrix that contains nonzero eigenvalues of matrix $S$. The matrix $S$ is an $N \times N$ cosine-theta matrix that captures the proportionality between each pair of Q sorts. Usually, the number of factor-defining Q sorts varies from factor to factor. Therefore, to ensure that the factor scores are comparable across factors, they are $z$-normalised so that every statement has the same mean (0) and standard deviation (1). The factor scores for each statement are z-normalized into factor $z$-scores according to the formula:

$$z = \frac{T_k - \overline{X_T}}{\sigma_T}$$

where $T$ is the sum of the weighted scores for the $k^{th}$ statement, $X_T$ is obtained by summing $T$ for all statements and dividing by the number of statements $K$. The parameter $\sigma_T$ is the standard deviation of the weighted scores distribution (Brown, 1982). A factor z-score for a statement represents the composite viewpoint of the participants in a factor for that statement. Factor $z$-scores are rank-ordered and then rounded up to integers to conform to the original Q-sort values that the researcher chooses for the Q-sort exercise to ease the interpretation of factors.[13]

Using the rank-orderings and the rounded factor z-scores, the Q statements are sorted into a factor array, for each factor.[14] Factor arrays are always produced along with the factor reliability data. Factor reliability is an index that measures the amount of confidence that can be placed in a factor. It indicates how likely a factor can be replicated if the participants are asked to repeat the Q-sort exercise. A factor reliability of at least 0.95 is deemed sufficiently high to achieve an unambiguous effect of a factor. However, an average reliability of 0.8 is considered

[11] An eigenvalue $\vartheta$, for a factor and a communality $h^2$ for a Q sort are both defined as the sum of squared factor loadings. However, whereas an eigenvalue for a factor is obtained by the summation of the squared factor loadings across the Q sorts, a communality of a Q sort, on the other hand, is obtained by the summation of the squared factor loadings across the factors

[12] In conventional R factor analysis, factor loadings are the most important parameters, which are used for the interpretation of results. In Q, however, factor scores, to be discussed in this section, are the parameters used for the interpretation of results (Brown, 1982).

[13] The original Q sort values refer to the values on the Likert scale that the researcher chooses for the Q sort exercise. Since the z-scores are usually not whole numbers, they are rounded-up so that they conform to Q sort values, which consist of integers. For example, the scale that is chosen for this study has Q sort values from − 2 to +2. That is − 2, − 1, 0, +1, and 2.

[14] Q statements that have been sorted according to the rank-orderings of the rounded z-factor scores are presented in a synoptic table called factor array (Schmolck, 2014. Creaser (1955) earlier defined a factor array as the arrangement of Q statements, which best characterize a factor.

**Table 1**
Q sample.

| No | Statement | No | Statement |
|---|---|---|---|
| 1 | Your farming practices have been influenced | 19 | The government should take back our land |
| 2 | The biofuel project has disorganized my farming | 20 | Loss of aesthetic landscape |
| 3 | There are increased employment opportunities | 21 | There is decreased grazing area |
| 4 | Mostly elites were employed by the project | 22 | Increased water pollution |
| 5 | Technology/new ideas have been introduced | 23 | I was compensated for the loss of my land |
| 6 | The project has better future for the community | 24 | The project has increased land conflicts |
| 7 | There is enhanced community status | 25 | The land was illegally acquired |
| 8 | The investors should expand the project | 26 | There is improved biodiversity |
| 9 | The investors are concerned with our welfare | 27 | The government has not protected our interest |
| 10 | Economic trees (shea trees) have been cleared | 28 | Improved overall environmental quality |
| 11 | I feel cheated | 29 | The wildlife habitat has increased |
| 12 | Local medication is adversely affected | 30 | Our chief gave out land in our interest |
| 13 | Medical herbs/trees have been cleared | 31 | The project has reduced rural poverty |
| 14 | There are jatropha poisoning of livestock | 32 | Poor working conditions for workers |
| 15 | The project failed to serve our interest | 33 | Food insecurity has reduced |
| 16 | The biofuel project made me poorer | 34 | All promises have been fulfilled |
| 17 | There is increased forest area | 35 | Enforceable contracts would have been useful |
| 18 | Our social relationships have been interrupted | 36 | Water have been diverted for biofuel project |

satisfactory. The formula for factor reliability $F_j$, for factor $j$, emanates from Brown (1982), which is:

$$F_j = \frac{0.8s}{1 + 0.8(s-1)} \tag{5}$$

where $s$ is the number of Q sorts that define factor $j$ and 0.8 is the average factor reliability. The more participants define a factor, the more reliable this factor is, and therefore, the smaller the size of the errors present in those factor scores. Factor reliability is very important because it feeds into calculating the standard errors of the factors. Consequently, it has impacts on the significance of the factor scores. The standard error $\sigma_E$, for a factor score can be obtained using the formula:

$$\sigma_E = \sigma_D \sqrt{(1 - F_j)} \tag{6}$$

where $\sigma_D$ is the standard deviation of the Q-sort distribut[15] The higher the factor reliability $F_j$, the lower the errors associated with factor $j$ (Brown, 1982).

### 4.7. Determining the significance of factor scores differences

The PQ Method evaluates each $z$ statement (a statement with normalized factor scores) at the significance levels of 0.01 or 0.05 for the factor scores. The test of significant difference between factor scores in any two factors $j_1$ and $j_2$ is accomplished by the standard error of differences $\sigma d_{j_1 - j_2}$, computed as

$$\sigma d_{j_1 - j_2} = \sqrt{(\sigma_{j_1}^2 - \sigma_{j_2 2}^2)} \tag{7}$$

Factor scores differences between factors $j_1$ and $j_2$ which differ by more than $2.58^{*}\sigma d_{j_1 - j_2}$ or $1.96^{*}\sigma d_{j_1 - j_2}$ are considered statistically different from 0 at the 0.01 or 0.05 levels respectively. This criterion is used to identify the statements that distinguish one factor from the others. Then, each factor type is ascribed to one subset of distinguishing statements represented as perspectives. The analysis of the Q sorts also generates a list of statements called consensus statements. A consensus statement fails to delineate one factor from the others as it has the same score across all the factors.[16]

## 5. Empirical procedure

The study communities are in Yendi Municipality in the northern region of Ghana. We conducted the Q sampling exercise between 29th March to 13th April 2023 at Kpaacha and Jimile communities. These are the most affected by the biofuel project operated by the Norwegian firm Solar Harvest - the project under this study. The biofuel project, Solar Harvest Ltd, was chosen for the study because it is the largest land-based agro-investment in Ghana (Boamah, 2011). The land was acquired from Tijo-Na, the Paramount Chief of Tijo Traditional Area. Our Q concourse was drawn from the relevant literature. However, during the interview with the Chief of Kpaacha and his elders, certain issues that we did not consider initially were raised. The concourse was subsequently modified to include those issues. We followed Barry and Proops (1999) and employed thirty-six statements for the Q-sort exercise. This Q sample size was considered manageable within the scope of the study. The Q sample is presented in Table 1.

### 5.1. Sample participants

About 40 participants (N = 40) participated in the Q-sort exercise. They were sampled using Snowball and Purposive sampling techniques. Through this procedure, the initial participants in the Q-sort task were asked to mention others with similar or different opinions about acquiring their land for the biofuel project. These methods were used because only participants who lost their farmlands to the biofuel project were targeted. An attempt was made to include a range of participants, such as men, women, migrants, and natives. The aim was to capture a broad range of people with diverse perspectives that would be representative of the concourse.

### 5.2. Q sort exercise

The standard procedure in which each participant is provided with the entire set of Q statements to examine and rank-order, was impossible for this study because many participants were illiterate. Therefore, for each participant, a preliminary sorting was carried out in which the statements were read, one at a time. Each participant was asked to classify the statements into three categories: agreement, neutral/ambivalent or disagreement. After this preliminary sorting exercise, the participants were asked to indicate their choices on a Likert scale ranging from − 2 (strongly disagree) to +2 (strongly agree), with a median value of 0 representing ambivalence. This was repeated for those statements in which the participant felt disagreement. This procedure necessitated the use of a free-sort distribution.

[15] The estimate of the standard deviation is $\sigma_D = 1$, if the factor scores are normalized.

[16] A distinguishing statement has a score, which is significantly different from factor to factor, as participants treat it differently, in contradistinction to a consensus statement, which according to Brown (1982), is a statement in which there is no statistical difference in the scores between any of the factors because the participants in each factor have similar views on it.

**Table 2**
Correlation between factors.

| Factors | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1.0000 | 0.4983 | 0.2980 | 0.5193 |
| 2 | 0.4983 | 1.0000 | 0.2731 | 0.3220 |
| 3 | 0.2980 | 0.2731 | 1.0000 | 0.2638 |
| 4 | 0.5193 | 0.3220 | 0.2638 | 1.0000 |

**Table 3**
Rotated factor loadings matrix for the participants. **X**: Sorts defining factor; **b**: impure Q sort; **% of sorts**: The percentage of participants defining the factor. Eigenvalue (**EV**): Accounted total variation in the Q sort distribution.

| Sorts | Factors | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Participant 1 | 0.0772 | 0.6688**X** | 0.0672 | −0.0137 |
| Participant 2 | 0.2732 | 0.0679 | 0.6078**X** | 0.0601 |
| Participant 3 | 0.1854 | 0.1242 | 0.1795 | 0.7618**X** |
| Participant 4**b** | 0.4933 | 0.3547 | 0.0718 | 0.3693 |
| Participant 5 | 0.6002**X** | 0.4159 | 0.3943 | −0.0405 |
| Participant 6**b** | 0.3746 | 0.4982 | 0.5539 | 0.1465 |
| Participant 7**b** | 0.2372 | −0.1562 | 0.3363 | 0.4413 |
| Participant 8 | 0.6491**X** | 0.0624 | 0.0097 | 0.1110 |
| Participant 9 | 0.5714**X** | 0.0907 | 0.0613 | 0.4713 |
| Participant 10 | 0.4219 | 0.1170 | 0.0256 | 0.6227**X** |
| Participant 11**b** | 0.3987 | 0.4341 | 0.3688 | −0.1545 |
| Participant 12 | 0.7448**X** | 0.1437 | 0.1592 | 0.2190 |
| Participant 13 | −0.0859 | −0.0027 | 0.3471**X** | −0.0271 |
| Participant 14 | 0.0453 | 0.1317 | 0.6753**X** | 0.2632 |
| Participant 15 | 0.4292**X** | 0.2710 | 0.2992 | −0.0429 |
| Participant 16 | 0.0391 | 0.6754**X** | 0.2013 | −0.0882 |
| Participant 17**b** | 0.1154 | 0.4948 | 0.3789 | −0.4252 |
| Participant 18 | −0.0020 | 0.3495 | 0.5170**X** | 0.1706 |
| Participant 19**b** | 0.3977 | 0.4908 | 0.4112 | 0.1838 |
| Participant 20**b** | 0.1927 | 0.1632 | 0.4013 | 0.3898 |
| Participant 21**b** | 0.1055 | 0.0150 | 0.3818 | 0.3947 |
| Participant 22 | 0.6548**X** | 0.2573 | 0.0972 | 0.1240 |
| Participant 23 | 0.7552**X** | 0.1008 | 0.0916 | −0.0235 |
| Participant 24 | 0.4584 | 0.6661**X** | 0.0258 | 0.2674 |
| Participant 25 | 0.6053**X** | 0.2583 | 0.0383 | 0.4264 |
| Participant 26 | 0.6348**X** | 0.1447 | 0.3973 | 0.2103 |
| Participant 27 | 0.6296**X** | 0.1547 | −0.2493 | 0.2667 |
| Participant 28 | 0.1883 | 0.6871**X** | 0.0928 | 0.1424 |
| Participant 29 | −0.0003 | 0.4503**X** | 0.1905 | 0.2223 |
| Participant 30 | 0.6378**X** | 0.0416 | 0.1206 | 0.2796 |
| Participant 31 | 0.6888**X** | 0.2933 | 0.2046 | 0.0885 |
| Participant 32**b** | 0.4663 | 0.3808 | −0.3482 | 0.4600 |
| Participant 33 | 0.7316**X** | 0.1298 | 0.2342 | 0.1761 |
| Participant 34**b** | 0.3732 | 0.3469 | 0.3218 | 0.4220 |
| Participant 35**b** | 0.3630 | 0.2524 | 0.1266 | 0.4198 |
| Participant 36 | 0.3536 | 0.6084**X** | −0.1916 | 0.2174 |
| Participant 37 | 0.3808**X** | 0.2550 | 0.2200 | 0.1139 |
| Participant 38**b** | 0.5179 | 0.5943 | −0.1832 | 0.2891 |
| Participant 39 | 0.6175**X** | 0.1864 | −0.1563 | 0.1114 |
| Participant 40 | 0.6518**X** | −0.0386 | 0.0075 | 0.2956 |
| % of sorts | 40 | 15 | 10 | 5 |
| % EV | 22 | 13 | 9 | 9 |

### 5.3. Q sorts analysis

The Q-sorts data which each participant provided, were statistically analyzed.[17] The Q statements were inputted in PQ Method, followed by entering the Q-sort statement numbers for each participant.[18] The data was then analyzed once PQ Method had accepted all the entries as consistent. A 40 × 40 correlation matrix between Q sorts (rankings by participants) was generated from the raw sorts. The generated inter-correlation matrix is available upon request.

Factor extraction was performed on the inter-correlation matrix using centroid analysis, which generated an unrotated factor loadings matrix. Initially, seven unrotated factors were extracted by default.[19] Among the seven unrotated factors, not all were relevant for further consideration. Two statistical criteria were used to identify the significant factors. These include the factors' eigenvalues and the Q sorts' communalities. Each of the unrotated factors was generated along with their eigenvalues. By taking Jolliffe (1972)'s and Kaiser (1960)'s criteria into consideration, 4 of the factors consisting of 1, 2, 4 and 6 with eigenvalues of 13.45, 3.19, 2.32, and 1.74 respectively were accepted. The eigenvalue of 13.45 for factor 1 means, for example, that approximately 34% (=13.45/40) of the variability in the correlation matrix is explained by factor 1. Factors 3, 5, and 7 have eigenvalues of 0.16, 0.14, and 0.08 respectively. These factors were excluded from further analysis because their eigenvalues are too low, suggesting that, individually, their contribution to explaining the total variance in the Q sort distribution is negligible. The contribution of each of the seven unrotated factors in explaining the total variation in the Q sort distribution can also be inferred from the cumulative communality matrix (not reported). The percentage of the total variation explained by factors 3, 5, and 7 is approximately zero. These factors were, therefore, insignificant according to these criteria, so they did not warrant further investigation.

After assessing the significance of the unrotated factors 1, 2, 4, and 6, they were rotated. Because it was not known a priori which underlying dimensions or factors were present, the factors were assumed to be independent and therefore, orthogonal rotation was performed using the standard varimax procedure. The varimax procedure was chosen because it helps improve the interpretation of factors by maximizing the spread of loadings within factors. Table 2 shows the correlation between the rotated factors. The factors are not highly correlated. The highest correlation is 0.519 between factors 1 and 4. This reassures the use of orthogonal rotation. The output of the varimax rotation is shown in Table 3. The entries are the rotated factor loadings.[20] The coefficients indicate the degree to which each participant is associated with each of the factors. The higher the factor loading of a participant on a factor, the more the participant represents that factor. The minimum value of a factor loading for a participant on a factor to assume significance at the 0.05 significance level is $0.31 = \left(\frac{1.96}{\sqrt{40}}\right)$.

Similarly, a factor loading which is greater than $0.41 = \left(\frac{2.58}{\sqrt{40}}\right)$ is significant at the 0.01 level. The participants who had significant loadings on one and only one factor, i.e., only pure Q sorts, were flagged with *X*, which indicates the defining sorts. The defining sorts identified the factors to which the respective participants belong. As shown in the synoptically organized Table 14, participant 1, for instance, is associated with factor 2, and participant 2 belongs to factor 3. The number of participants who loaded significantly on factor 1 is 16, representing 40% of the participants. That is, 16 participants shared similar perspectives and factor 1 represents it. The 16 participants explained 22% of the variation in the Q sort distribution. The number of participants associated with factor 2 is 6, representing 15% of the participants.

#### 5.3.1. "Impure" factor loadings

The factor loadings matrix in Table 3 includes "impure" factor loadings. All the sorts that loaded significantly (> 0.31) at the 0.05 level on more than one factor or loaded similarly on several factors are

[17] PQ Method is the statistical software that is designed for the analysis of data in Q studies. The term "PQ" has no definitive basis. PQ Method software is available at http://schmolck.userweb.mwn.de/qmethod/index.htm and the associated manual can be found at http://schmolck.org/qmethod/pqmanual.htm

[18] The PQ Method is convenient for identifying duplicates and missing statement numbers.

[19] The researcher has the option to extract more or less than the default number of unrotated factors if they know a prior how many unrotated factors are relevant.

[20] In the remainder of the document, -"rotated factor loading" will simply be referred to as "factor loadings".

**Table 4**
Factor reliability.

| Factor characteristics | Factors | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Number of defining sorts | 16 | 6 | 4 | 2 |
| Average reliability coefficient | 0.800 | 0.800 | 0.800 | 0.800 |
| Factor reliability | 0.985 | 0.960 | 0.941 | 0.889 |
| S.E. of factor Z-scores | 0.124 | 0.200 | 0.243 | 0.333 |

**Table 5**
Standard error of differences between factor scores. The diagonal entries are standard errors within factors.

| Factors | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 0.175 | 0.235 | 0.272 | 0.356 |
| 2 | 0.235 | 0.283 | 0.314 | 0.389 |
| 3 | 0.272 | 0.314 | 0.343 | 0.412 |
| 4 | 0.356 | 0.389 | 0.412 | 0.471 |

"impure", i.e., they loaded ambiguously (see, for example, participants 4, 6, 7, and 11). Consequently, none of their factor loadings was flagged. If a participant loads significantly on more than one factor, it implies that the participant does not have a focused point of view, i.e., a sign of a mixture of perspectives or that he or she is simply idiosyncratic. Specifically, about 12 participants, marked with superscript b, were not flagged from the factor loadings matrix. Each of these participants has perspectives unrelated to any other participant. These participants were omitted from further analysis to avoid errors in interpreting the results.

*5.3.2. Factor scores and reliability of the factors*

After we identified the number of important factors and the factors to which each participant belonged, the subset of Q statements associated with each factor was identified with the aid of factor scores (weighted scores). Table 13 in the Appendix shows the factor scores with their corresponding ranks for each statement. A rank score for a statement in a factor illustrates the importance that the participants in this factor attach to that statement relative to the other statements in the same factor. A factor score for a statement in a factor represents the composite viewpoint of all the participants. For example, for statement number 1, *your farming practices have been influenced*, the participants in factor 1 scored it 2.09 (strong agreement), and those in factor 2 scored it − 0.7 (somewhat ambivalent, but close to disagreement). The participants in factor 3 scored this statement 1.88 (close to strong agreement), and it received a weighted score of −0.94 (disagreement) by the participants constituting factor 4. However, the number of sorts which defined each factor varied from factor to factor, as shown in Table 3. Whereas 16 participants constitute factor 1, only 2 participants defined factor 2. To ensure that the factor scores are comparable across factors, they were z-normalized. The z-scores are not expressed as whole numbers. Therefore, for convenience, they were rounded up and expressed in terms of the Q sort values, i.e., [ − 2, − 1, 0, +1, +2]. For example, using the statement number 1, *your farming practices have been influenced*, the factor z-scores for this statement under factors 1, 2, 3, and 4 are respectively, 2.095, − 0.705, 1.877, and − 0.955. These factor z-scores were rounded up as [2, − 1, 2, − 1] and entered into a table that contains the factor arrays.

The entire factor arrays are reported in Table 14 in the Appendix. An element of the factor array, for a statement, represents the composite viewpoint of all the participants in the respective factor for that statement. The factor z-scores and their corresponding elements in the factor arrays serve the same purpose except that the factor arrays are more revealing since they contain elements that are equivalent to the Q sort values. They were sorted according to the rank-orderings of the factor z-scores. The factor reliability data are presented in Table 4. Except for factor 4, which has a reliability of 0.889, the factors have sufficiently high reliabilities. This means that a high level of confidence can be placed in the generated factors, i.e., a similar set of factors is likely to emerge when the same set of participants are made to repeat the Q-sort exercise. In addition, the estimated standard errors of the factor scores, also reported in Table 4 could be described as credible since the factor reliabilities fed into the computation of the standard errors.

*5.3.3. Significance of the factor scores*

The standard error of differences reported in Table 5 was used to establish the magnitudes of the factor score differences required to induce significance at the 0.01 and the 0.05 levels.[21] Table 6 details the derivation of the magnitudes. The minimum magnitude obtained for each factor score difference to assume significance approximates 1.00 for the 0.01 significance level and between 0.50 and 1.00 for the 0.05 significance level. Therefore, the derived minimum magnitudes are 1.00 for the 0.01 level and 0.50 for the 0.05 level. The factor score differences between the factors for each statement are presented in Table 7. Because the factor scores were z-normalised, the difference scores must follow a normal curve. Therefore, for each statement, in absolute terms, a factor score difference between any two factors greater than 1.00 is considered statistically different from 0 at $p < 0.01$. This will suggest that the given statement has distinguished (discriminated) between the two factors. In the same way, a factor score difference that is greater than 0.50 is considered as significant at $p < 0.05$.

*5.3.4. Identifying perspectives and consensus statements*

The factor score differences shown in Table 7 were used to identify which statements distinguished one factor (cluster of participants with similar viewpoints or perspectives) from the others. Then, the statements that suggested a complete pattern of responses, which adequately represented the overall points of view for a cluster of participants, were integrated and represented as perspectives. For a statement to be significant under a factor, all the 3-factor score differences must be significant. From Table 7, the statements with significant factor score differences between factor 1 and each of the other factors, i.e., 1 and 2, 1 and 3, 1 and 4, are distinguishing statements for factor 1. In absolute terms, a factor score difference between any two factors greater than 1.00 is significant at $p < 0.01$. Similarly, in absolute terms, a factor score difference greater than 0.500 is significant at $p < 0.05$. All the factor score differences that are in bold are significant at the 0.01 level or the 0.05 level. For a statement to be significant under a factor, all the 3 factor scores differences must be significant.

Similarly, the statements which have significant factor score differences between factor 2 and each of the other factors, i.e., 2 and 1, 2 and 3, 2 and 4 are distinguishing statements for factor 2. Thus, for a statement to be associated with factor 1, the factor score differences between factor 1 and each of the other factors must all be significant at the 0.01 level or a combination of 0.01 and 0.05 levels. For example, statement 1 is not a distinguishing statement for factor 1 because the factor score difference between factors 1 and 3 is insignificant even though the differences between 1 and 2, 1 and 4 are both significant. However, statement 9 is a distinguishing statement for factor 1 because the factor score differences between factor 1 and the other factors are significant at the 0.01 or both 0.01 and 0.05 levels. The distinguishing statements for the other factors can be identified similarly.

The number of distinguishing statements for each factor varied because the number of statements that received significantly different z-scores compared to those scores received in other factors varied as well. The statements which have none of the 3-factor score differences being significant are the consensus statements. Those statements that failed to

[21] Recall also, from Section 4.2.4.4 that the formula for minimum magnitude of a factor score difference, that is required to induce significance at a given significance level, is the product of the standard error of differences (Table 5) and the multiplier of that significance level.

**Table 6**
Magnitudes of factor score differences to induce significance. A factor score difference for a statement is significant at $p < 0.01$ if the factor score difference > 1.00. A factor score difference for a statement is significant at $p < 0.05$ if the factor score difference > 0.50. The upward rounding of the magnitudes for the factor score differences is consistent with the upward adjustment of the factor *z*-scores into Q sort values (Q sort scale values).

| Factors | 1 & 2 | 1 & 3 | 1 & 4 | 2 & 3 | 2 & 4 | 3 & 4 |
|---|---|---|---|---|---|---|
| **Significance at 0.01** | | | | | | |
| Magnitude | 0.235*2.58 | 0.272*2.58 | 0.356*2.58 | 0.314*2.58 | 0.389*2.58 | 0.412*2.58 |
| = (≈) | 0.61(1) | 0.70(1) | 0.92(1) | 0.81(1) | 1.0(1) | 1.1(1) |
| **Significance at 0.05** | | | | | | |
| Magnitude | 0.235*1.96 | 0.272*1.96 | 0.356*1.96 | 0.314*1.96 | 0.389*1.96 | 0.412*1.96 |
| = (≈) | 0.46(0.5) | 0.54(0.5) | 0.70(1) | 0.62(1) | 0.76(1) | 0.81(1) |

**Table 7**
Array of factor score differences between factors. A factor score difference between any two factors, which is greater than 1.00, in absolute terms, is significant at p < 0.01. Similarly, a factor score difference that is greater than 0.500, in absolute terms, is significant at p < 0.05. For a statement to be significant under a factor, all the 3 factor scores differences must be significant. The asterisk * indicates a distinguishing statement for factor 1, ** indicates a distinguishing statement for factor 2, *** indicates a distinguishing statement for factor 3, and **** indicates a distinguishing statement for factor 4. These are examples. The other distinguishing statements for the factors can be identified similarly from the table. **xxxx** indicates that no factor score difference is significant.

| No | Statement | Factor scores differences | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 & 2 | 1 & 3 | 1 & 4 | 2 & 3 | 2 & 4 | 3 & 4 |
| 1 | Your farming practices have been influenced | 2.799 | 0.218 | 3.039 | −2.581 | 0.240 | 2.821 |
| 9 | *The investors are concerned with our welfare | 2.222 | 3.192 | 0.931 | 0.971 | −1.291 | −2.262 |
| 5 | Technology/new ideas have been introduced | 1.281 | −1.425 | −1.281 | −2.706 | −2.562 | 0.144 |
| 29 | The wildlife habitat has increased | 1.045 | 1.163 | 0.302 | 0.118 | −0.743 | −0.861 |
| 3 | There are increased employment opportunities | 0.929 | 0.456 | −1.136 | −0.473 | −2.065 | −1.592 |
| 7 | There is enhanced community status | 0.845 | 2.790 | 0.107 | 1.945 | −0.738 | −2.683 |
| 26 | **There is improved biodiversity | 0.835 | −0.571 | −0.630 | −1.406 | −1.465 | −0.059 |
| 28 | Improved overall environmental quality | 0.742 | −0.628 | −1.409 | −1.370 | −2.151 | −0.781 |
| 8 | The investors should expand the project | 0.660 | 0.942 | −1.392 | 0.281 | −2.052 | −2.334 |
| 36 | Water have been diverted for biofuel project | 0.651 | 0.354 | 0.238 | −0.297 | −0.412 | −0.115 |
| 2 | The project has disorganized my farming | 0.566 | −0.468 | 0.451 | −1.034 | −0.115 | 0.919 |
| 25 | The land was illegally acquired | 0.239 | −0.067 | 0.492 | −0.306 | 0.252 | 0.559 |
| 33 | xxxx Food insecurity has reduced | 0.200 | 0.132 | 0.374 | −0.068 | 0.174 | 0.242 |
| 4 | Mostly elites were employed by the project | 0.193 | −1.102 | 0.258 | −1.295 | 0.064 | 1.360 |
| 32 | Poor working conditions for casual workers | 0.130 | 0.126 | 0.734 | −0.004 | 0.605 | 0.608 |
| 34 | All promises have been fulfilled | 0.102 | 0.874 | 1.010 | 0.772 | 0.908 | 0.135 |
| 19 | The Government should take back our land | 0.075 | −1.734 | −0.024 | −1.809 | −0.099 | 1.710 |
| 27 | The Government has not protected our interest | −0.003 | 0.490 | −0.523 | 0.494 | −0.520 | −1.013 |
| 10 | Economic trees (shea trees) have been cleared | −0.024 | 0.601 | 0.882 | 0.625 | 0.906 | 0.281 |
| 11 | I feel cheated | −0.098 | 0.877 | 0.808 | 0.975 | 0.906 | −0.068 |
| 12 | Local medication is adversely affected | −0.125 | 0.964 | 0.895 | 1.089 | 1.020 | −0.068 |
| 35 | Enforceable contracts would have been useful | −0.256 | −0.382 | 0.391 | −0.126 | 0.647 | 0.773 |
| 23 | I was compensated for the loss of my land | −0.356 | −0.334 | 0.676 | 0.022 | 1.031 | 1.009 |
| 24 | The project has increased land conflicts | −0.436 | −0.626 | 0.211 | −0.190 | 0.647 | 0.838 |
| 31 | The project has reduced rural poverty | −0.443 | 0.574 | −0.888 | 1.017 | −0.446 | −1.463 |
| 30 | Our chief gave out land in our interest | −0.503 | 1.187 | −0.276 | 1.690 | 0.227 | −1.463 |
| 14 | There is jatropha poisoning of livestock | −0.563 | −1.686 | −0.699 | −1.124 | −0.136 | 0.987 |
| 6 | ****The project has better future the community | −0.792 | −0.743 | −2.027 | 0.049 | −1.235 | −1.284 |
| 21 | There is decreased grazing area | −0.856 | 0.646 | 1.120 | 1.502 | 1.977 | 0.474 |
| 16 | The biofuel project made me poorer | −0.865 | −1.528 | −0.084 | −0.663 | 0.781 | 1.444 |
| 13 | Medical herbs/trees have been cleared | −0.877 | 1.062 | 0.144 | 1.939 | 1.020 | −0.918 |
| 15 | ***The project failed to serve our interest | −0.919 | −1.668 | −0.568 | −0.750 | 0.351 | 1.100 |
| 17 | There is increased forest area | −1.249 | −1.956 | −1.328 | −0.707 | −0.079 | 0.628 |
| 18 | Our social relationships have been interrupted | −1.408 | −1.324 | −1.194 | 0.084 | 0.214 | 0.130 |
| 22 | Increased water pollution | −1.854 | 0.063 | 0.662 | 1.917 | 2.516 | 0.599 |
| 20 | Loss of aesthetic landscape | −1.888 | −0.467 | −0.265 | 1.421 | 1.623 | 0.203 |

distinguish one factor significantly from all the others were categorized as consensus statements.[22] This is because they received similar scores from the participants in all the factors (see Section 4.2.4.4 for definitions of distinguishing and consensus statements). The statements, insignificant at 0.01 and 0.05 levels under any factor, illustrate deeper consensus levels (see for example statement 33).

[22] The statements, which have significant factor score differences only at the 0.05 level are also categorized as consensus statements (see statement 24 for example). This is because a significant factor difference at the 0.05 level is considered weak to discriminate one factor from the other, compared to the 0.01 level.

## 6. Results: community perspectives

The findings of this analysis consist of community perspectives (a variety of shared viewpoints) towards acquiring communal land for biofuel production at Kpaacha and Jimile in Yendi Municipality, northern Ghana. Each perspective identifies the generic outline of opinions a cluster of participants holds. The identified perspectives (factors) are presented below in the order of importance, based on the number of participants holding that perspective (see Table 4).

### 6.1. *Perspective 1: "pro-biofuel project, but …"*

The distinguishing statements for Factor 1 are presented in Table 8. The factor consists of 16 people, making perspective 1 the most

**Table 8**
Distinguishing statements for factor 1. All the listed statements are significant at $p < 0.05$. The asterisk (*) indicates significance at $p < 0.01$. The scores gained by these statements in this factor significantly differ from those they gained in the other factors. The Q sort values (rounded $z$-scores) are equivalent to the $z$-score values.

| No. | Statement | Q-sort value | Z- score |
|---|---|---|---|
| 9 | The investors are concerned with our welfare | 2 | 1.79* |
| 5 | Technology/new ideas have been introduced | 1 | 0.11* |
| 8 | The investors should expand the project | 1 | 0.00* |
| 21 | There is decreased grazing area | 0 | −0.07 |
| 28 | Improved overall environmental quality | 0 | −0.26 |
| 18 | Our social relationships have been interrupted | −1 | −0.53* |
| 6 | The project has better future for the community | −1 | −0.63* |
| 17 | There is increased forest area | −1 | −0.71* |
| 14 | There are livestock deaths through jatropha poisoning | −2 | −1.35 |

**Table 9**
Distinguishing statements for factor 2. All the listed statements are significant at $p < 0.05$. The asterisk (*) indicates significance at $p < 0.01$.

| No. | Statement | Q-sort value | Z-score |
|---|---|---|---|
| 13 | Medical herbs/trees have been cleared | 2 | 1.88* |
| 22 | Increased water pollution | 2 | 1.28* |
| 20 | Loss of aesthetic landscape | 1 | 1.17* |
| 21 | There is decreased grazing area | 1 | 0.79* |
| 16 | The biofuel project made me poorer | 0 | 0.13 |
| 9 | The investors are concerned with our welfare | 0 | −0.43* |
| 26 | There is improved biodiversity | −2 | −0.85* |
| 28 | Improved overall environmental quality | −2 | −1.00* |
| 5 | Land prices in your community have increased | −2 | −1.17* |

important of all the perspectives. This perspective supports the establishment of the biofuel project, but the people are despondent about the project's possibilities in reducing rural poverty. Although the perspective appreciates that the biofuel investors have shown interest in their welfare and have introduced new technology into the community, it casts doubt on the project's prospects of improving the community members' livelihoods. It is also concerned that the community's social fabric and relationships have been compromised because of the increased migration of people to nearby towns and cities. The perspective recognizes that the biofuel project does not affect their livestock rearing concerning grazing area and jatropha poisoning. It is neutral on the project's effect on the environmental quality and does not consider the jatropha plantation as an increase in the forest area.

### 6.2. *Perspective 2: "pro-environment"*

The striking feature of this perspective is its environmental and ecological orientations, as displayed by the distinguishing statements in Table 9. The perspective primarily displays a strong concern about physical environmental issues. The participants are indifferent about the impact of the biofuel project on their economic livelihoods, but in general, this perspective is critical of the biofuel project; it sees the project as having negative impacts on the physical environment. Participants fear increased water pollution, aesthetic landscape loss and biodiversity loss. They also bemoaned the destruction of trees and medicinal herbs. However, they recognize that the biofuel project has had no impact on the area's land price.

### 6.3. *Perspective 3: "anti-biofuel project, quit the project!"*

This perspective is strongly against the establishment of the biofuel project. The distinguishing statements for factor 3 in Table 10 below provide the evidence. The participants are critical of the role of their Paramount Chief in leasing out the communal land to the biofuel

**Table 10**
Distinguishing statements for factor 3. All the listed statements are significant at $p < 0.05$. The asterisk (*) indicates significance at $p < 0.01$.

| No. | Statement Q-sort value | Z-score | |
|---|---|---|---|
| 19 | The Government should take back our land | 2 | 1.30* |
| 16 | The biofuel project made me poorer | 1 | 0.79 |
| 4 | Mostly, elites are employed by the project | 1 | 0.61* |
| 15 | The project failed to serve our interest | 1 | 0.45 |
| 14 | There are livestock deaths through jatropha poisoning | 0 | 0.33 |
| 13 | Medical herbs/trees have been cleared | 0 | −0.06 |
| 7 | There is enhanced community status | −2 | −1.29* |
| 30 | Our chief gave out land in our interest | −2 | −1.38* |
| 31 | The project has reduced rural poverty | −2 | −1.38 |
| 9 | The investors are concerned with our welfare | −2 | −1.40* |

**Table 11**
Distinguishing statements for factor 4. All the listed statements are significant at $p < 0.05$. The asterisk (*) indicates significance at $p < 0.01$.

| No. | Statement | Q-Sort Value | Z-score |
|---|---|---|---|
| 3 | There are increased employment opportunities | 2 | 1.39* |
| 6 | The project has better future for the community | 2 | 1.39* |
| 8 | The investors should expand the project | 2 | 1.39* |
| 9 | The investors are concerned with our welfare | 1 | 0.86* |

investors. The perspective considers that the project has failed to meet expectations regarding improving rural livelihoods. It does not recognize any positive contribution of the biofuel project in improving the community status; rather, it has deepened poverty. It observes that the elites were mainly offered jobs with the biofuel project. The extent to which this perspective disapproves of the biofuel project is revealed in its call on the Government to shut down the project and recover the community land. It perceives the Government as having failed in its responsibility to protect participants' interests. The perspective does not have environmental concerns.

### 6.4. *Perspective 4: pro-biofuel project, "expand the project!"*

The statements peculiar to factor 4 are shown in Table 11. This factor comprises only two participants, making it the least important perspective. The perspective is remarkably optimistic about the biofuel investment. It expresses positive views about the biofuel project and strongly desires to expand it. It identifies the biofuel project as having better prospects in improving rural livelihoods and acknowledges the increased employment opportunities. This perspective is not critical of the environmental issues associated with the biofuel project. It is also silent on social issues such as disruption of communal relations as in perspective 1.

### 6.5. *Consensus statements*

Table 12 contains the list of consensus statements among the four factors. There is a deep consensus that the biofuel project's establishment destroyed economic trees, mainly Shea and Dawadawa. A deep consensus also emerged that the employees of the biofuel project do not receive proper treatment and working conditions and that the Government has shirked its responsibilities in protecting their rights. There is strong agreement that the acquisition of the land has not led to communal land conflicts and, what is more, that the biofuel investors legally acquired the communal land. This is surprising because the participants were neither involved in the land acquisition process nor given prior notice about their evacuation. They, however, agreed that enforceable social contracts between the communities and the investors would have been useful so that the investors would be compelled to fulfil their promises to the chiefs. The people also debunked that the biofuel

**Table 12**
Consensus statements. All the listed statements are insignificant at $p > 00.01$, and those flagged with an * are also insignificant at $p > 0.05$. The statements which are insignificant at the 0.05 level illustrate deeper consensus levels. + = agreement with the statement, - = disagreement with the statement.

| No. | Statement | Response |
|---|---|---|
| 10 | Economic trees have been cleared* | + |
| 24 | The project has increased land conflicts | – |
| 25 | The land was illegally acquired* | – |
| 27 | The Government has not protected our interest | + |
| 32 | Poor working conditions for casual workers | + |
| 33 | Food insecurity has reduced* | – |
| 35 | Enforceable contracts would have been useful* | + |

project has helped improve the community's food security situation.

## 7. Discussion

The primary objective of this study was to capture the community perspectives towards the acquisition of communal land for biofuel production in northern Ghana. Using Q analysis, the perspectives among the community members of Kpaacha and Jimile in northern Ghana, towards acquiring their land for a biofuel project were extracted. The analysis revealed what the participants feel and think about losing their farmlands to the biofuel project and the operations of the biofuel project in general.

The study has revealed that some community members, represented by factor 1, are not opposed to establishing the biofuel project. They, however, believe more could be done to improve the livelihoods of the host community. The people explained that many promises, but nothing has happened in this regard. Those who hold this view constitute the majority and are associated with factor 1. This factor has the highest reliability of 0.985, making perspective 1 the most important. Both the Assembly Member for Jimile Electoral Area and the Community Chief of Kpaacha admitted that the biofuel company provided the affected communities with a dam. However, the people are not enthusiastic about the dam because the promises the company made but has reneged on were numerous. The Chief expressed his discontentment: The extent of the peoples' discontentment expressed by a major stakeholder, the Assembly Member for Jimile Electoral Area, can be inferred from the following solemn statement:

> *"…, the people are suffering. Have you not seen the community? Many people have left the community because they have no land to farm. When they came here [the biofuel investors], they made a lot of promises before establishing the biofuel project. They promised us job opportunities, payment of allowances to local schoolteachers, and provision of health posts. I am the Assembly Member for this area but I cannot go near this Chief to talk about this issues. He is so powerful that even the Municipal Chief Executive fears him…"*

Another group, represented by factor 2, disapproves of the biofuel project because of its physical environmental ramifications. They are concerned with the loss of biodiversity, the destruction of the trees and medicinal herbs and the loss of the aesthetic environment due to the establishment of the jatropha plantation. One of the elders in the Kpaacha chief's palace made the following remark to register his displeasure with the biofuel project:

> *"…, you cannot just stand here and imagine the size of the jatropha plantation. It will take you several hours to go round the project. All the trees are gone, and now the whole place is just open…"*

Then, there is a strong against group represented by factor 3; they consider the biofuel project as having deepened their miseries because it has failed to help improve their livelihoods. Therefore, they called on the Government to shut down the biofuel project and recover their farmlands. A woman who claimed her maturing pepper crops were destroyed to make way for the jatropha plantain bemoaned:

> *My pepper was still growing on my plot. They told me they will give me money, but I did not hear from anyone.* [23]

Although some persons, represented by factor 4, have expressed positive views about the biofuel project, they constitute the smallest group, as revealed by the defining sorts in the factor loadings matrix. The reliability index is also the lowest, 0.889, for the associated factor. The consensus statements revealed the common perspective of the land-losing community members. There is a consensus that economic trees were felled to make way for the biofuel project. These include shea and dawadawa trees whose fruits are used to extract butter and condiments, respectively. These products constitute the most important income sources, especially for rural women in northern Ghana (West, 2004). There is also a general agreement that the biofuel project has not contributed to improving the food security situation in the community. They also believe the lack of enforceable social contracts motivated the biofuel investors to renege on their promises. The people are not happy about the treatment meted out to the employees of the biofuel company. This is especially concerning payment of salaries where they claimed that salaries were not paid on time, and in some instances, full salary payments were not made. A former employee of the biofuel company stated with regret:

> *I used to farm and have enough money on me. When the opportunity came for me to be employed as a machine operator, I was happy. But it can take 2 or 3 months before the salaries will come. Sometimes, they do not pay all the money.*

The richness of the analysis and the statistically rigorous results that were extracted from the Q sorts' analysis are encouraging concerning the choice and application of Q in evaluating community perspectives. Some studies Amigun et al. (2011b),a); Selfa et al. (2011); Obidzinski et al. (2012); German et al. (2011) only provided the percentage of participants who agree or disagree with certain issues related to biofuel activities. Of course, Q analysis also produces this kind of percentages. The added advantage of Q analysis is that it provides an insightful exploration of perspectives by simultaneously pointing out shared opinions and divergent viewpoints on various issues. However, the results from some of these studies point to similar evidence as adduced from our Q study. For example, Obidzinski et al. (2012) studied the social and environmental impacts of biofuel production in Indonesia, and they found that 58% of the participants complained of a decrease in water quality, 37% complained of air pollution, and 31% attributed the increase in human diseases in their locality to the biofuel activities. German et al. (2011) examined biofuel production's social and environmental impacts in Southern Ghana. They found that 98% of the participants reported a declining contribution of forest to their livelihoods, 73% complained of a decline in their agricultural production and about 73% conceived of a total decline in their living standards.

Even though Q results are interesting and provide a rich analysis of perspectives, they are not meant for extrapolation but rather to examine the variability among stakeholder groups and offer useful insights into the typologies of perspectives that exist in a particular circumstance. It has been argued that Q does not necessarily produce the same results when repeated with the same-targeted group, thus questioning the reliability of its results. However, Barry and Proops (1999), and Brown (1982) point out that individuals are dynamic in their perspectives. Therefore, they cannot be expected to express the same views simultaneously. Q results can be simulated 85% consistently up to a year and Q

[23] When we ask the woman whether she followed up to make a claim for the promised compensation, she said her husband followed up to the chief palace, but they did not get any feedback.

**Table 13**
Factor scores with corresponding ranks. A factor score for a statement in a factor is a weighted score that captures the composite viewpoints of all the participants for that statement in the factor. A rank score for a statement in a factor tells the importance that the participants in this factor attach to that statement relative to the other statements.

| No | Statements | Factors scores and ranks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | 2 | | 3 | | 4 | |
| | | Score | Rank | Score | Rank | Score | Rank | Score | Rank |
| 1 | Your farming practices have been influenced | 2.0 | 1 | −0.70 | 29 | 1.88 | 1 | −0.94 | 29 |
| 2 | The biofuel project has disorganized my farming | 0.77 | 9 | 0.21 | 14 | 1.24 | 5 | 0.32 | 17 |
| 3 | There are increased employment opportunities | 0.26 | 10 | −0.67 | 25 | −0.20 | 20 | 1.39 | 5 |
| 4 | Mostly elites were employed by the project | −0.49 | 23 | −0.68 | 26 | 0.61 | 12 | −0.75 | 27 |
| 5 | Technology/new ideas have been introduced | 0.11 | 11 | −1.17 | 34 | 1.54 | 2 | 1.39 | 5 |
| 6 | The project has better future for the community | −0.63 | 26 | 0.16 | 15 | 0.11 | 18 | 1.39 | 5 |
| 7 | There is enhanced community status | 1.50 | 6 | 0.66 | 10 | −1.29 | 31 | 1.39 | 5 |
| 8 | The investors should expand the project | 0.00 | 13 | −0.66 | 24 | −0.94 | 28 | 1.39 | 5 |
| 9 | The investors are concerned with our welfare | 1.79 | 2 | −0.43 | 21 | −1.40 | 34 | 0.86 | 11 |
| 10 | Economic trees (shea trees) have been cleared | 1.74 | 4 | 1.76 | 4 | 1.14 | 7 | 0.86 | 11 |
| 11 | I feel cheated | 1.67 | 5 | 1.76 | 4 | 0.79 | 11 | 0.86 | 11 |
| 12 | Local medication is adversely affected | 1.75 | 3 | 1.88 | 2 | 0.79 | 11 | 0.86 | 11 |
| 13 | Medical herbs/trees have been cleared | 1.00 | 8 | 1.88 | 2 | −0.06 | 19 | 0.86 | 11 |
| 14 | There are jatropha poisoning of livestock | −1.35 | 36 | −0.79 | 30 | 0.33 | 17 | −0.65 | 26 |
| 15 | The project failed to serve our interest | −1.22 | 33 | −0.30 | 19 | 0.45 | 14 | −0.65 | 26 |
| 16 | The biofuel project made me poorer | −0.74 | 29 | 0.13 | 16 | 0.79 | 11 | −0.65 | 26 |
| 17 | There is increased forest area | −0.71 | 27 | 0.54 | 11 | 1.24 | 5 | 0.61 | 16 |
| 18 | Our social relationships have been interrupted | −0.53 | 24 | 0.87 | 8 | 0.79 | 11 | 0.66 | 12 |
| 19 | The government should take back our land | −0.43 | 21 | −0.51 | 22 | 1.30 | 3 | −0.41 | 22 |
| 20 | Loss of aesthetic landscape | −0.72 | 28 | 1.17 | 7 | −0.25 | 21 | −0.46 | 23 |
| 21 | There is decreased grazing area | −0.07 | 16 | 0.79 | 9 | −0.71 | 27 | −1.19 | 32 |
| 22 | Increased water pollution | −0.57 | 25 | 1.28 | 5 | −0.64 | 25 | −1.23 | 33 |
| 23 | I was compensated for the loss of my land | −1.05 | 32 | −0.69 | 28 | −0.71 | 27 | −1.72 | 36 |
| 24 | The project has increased land conflicts | −0.98 | 31 | −0.54 | 23 | −0.35 | 22 | −1.19 | 32 |
| 25 | The land was illegally acquired | −0.45 | 22 | −0.69 | 28 | −0.39 | 23 | −0.94 | 29 |
| 26 | There is improved biodiversity | −0.02 | 14 | −0.85 | 31 | 0.56 | 13 | 0.61 | 16 |
| 27 | The government has not protected our interest | 0.09 | 12 | 0.09 | 17 | −0.40 | 24 | 0.61 | 16 |
| 28 | Improved overall environmental quality | −0.26 | 20 | −1.00 | 32 | 0.37 | 15 | 1.15 | 6 |
| 29 | The wildlife habitat has increased | −0.11 | 17 | −1.15 | 33 | −1.27 | 30 | −0.41 | 22 |
| 30 | Our chief gave out land in our interest | −0.20 | 19 | 0.31 | 12 | −1.38 | 33 | 0.08 | 19 |
| 31 | The project has reduced rural poverty | −0.81 | 30 | −0.37 | 20 | −1.38 | 33 | 0.08 | 19 |
| 32 | Poor working conditions for workers | 1.35 | 7 | 1.22 | 6 | 1.22 | 6 | 0.61 | 16 |
| 33 | Food insecurity has reduced | −1.35 | 35 | −1.55 | 35 | −1.48 | 35 | −1.72 | 36 |
| 34 | All promises have been fulfilled | −0.18 | 18 | −0.28 | 18 | −1.05 | 29 | −1.19 | 32 |
| 35 | Enforceable contracts would have been useful | −0.02 | 15 | 0.24 | 13 | 0.36 | 16 | −0.41 | 22 |
| 36 | Water have been diverted for biofuel project | −1.24 | 34 | −1.89 | 36 | −1.59 | 36 | −1.48 | 34 |

elucidates personal opinions concerning a topic, so validity is not a consideration (Brown, 1993). As Kitzinger (1987) put it, the aim of Q is not to establish the truth but to explore and capture the communalities and the diversity of views held by the people concerned. Another characteristic of Q, which lends itself to criticism, is that the interpretation of the factors that emerge from Q analysis is open to risk, as the task of the interpretation lies with the researcher. We minimised this risk by soliciting qualitative information from the participants.

## 8. Conclusion and policy implications

The objective of this study was to map community perspectives on the acquisition of communal land for biofuel production in northern Ghana. Regarding the literature on land acquisitions for biofuel production, this study is one of the few to explore the complex issue of community perspectives using the Q approach. The analysis suggests that Q has a profound potential for both ecological and environmental economics where, frequently, the derivation of appropriate policies hinges on human subjective opinions. Applying Q analysis, we extracted four community perspectives, in the order of importance as follows: (1) pro-biofuel project, but pessimistic (2) against the biofuel project (pro-environmental) (3) strong against and (4) optimistic. The explored community perspectives, in general, suggest the community members are dissatisfied with the biofuel operations, particularly the ecological and environmental concerns, the failed promises and the unaddressed grievances related to the loss of land. Our recommendations are as follows: (1) To prevent investors from reneging their promises, enforceable social and economic contracts should be established between the local land users, employees, and biofuel investors (2) monetary compensations for the affected communal land users (3) investigative into claims that workers in the biofuel project are not paid in full or on time (4) future communal land sale decisions should involve extensive community consultations and take into account the interests, worries, and opinions of the local land users and (5) the local bioenergy policy of the government of Ghana must include checks on communal land lease decisions, which directly or indirectly impact the welfare of the people.

## CRediT authorship contribution statement

**Moses Mananyi Kupabado:** Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization, Validation, Visualization, Writing – original draft, Writing – review & editing. **Akwasi Mensah-Bonsu:** Methodology, Visualization, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Table 14**
Factor arrays with factor Q-sort values for each statement. The factor array elements are the equivalent values for the factor z-scores. The factor z-scores were rounded up to conform to the Q sort values, i.e., [ − 2 − 1 0 +1 +2], that was used for the Q sort exercise.

| No. | Statement | Factors | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| 33 | Food insecurity has been reduced | −2 | −2 | −2 | −2 |
| 25 | The land was illegally acquired | 0 | −1 | −1 | −1 |
| 36 | Water have been diverted for biofuel project | −2 | −2 | −2 | −2 |
| 32 | Poor working conditions for casual workers | 1 | 2 | 2 | 0 |
| 35 | Enforceable contracts would have been useful | 0 | 1 | 0 | 0 |
| 24 | The project has increased land conflicts | −2 | −1 | 0 | −2 |
| 27 | The government has not protected our interest | 1 | 0 | −1 | 0 |
| 10 | Economic trees (shea trees) have been cleared | 2 | 2 | 1 | 1 |
| 2 | The biofuel project has influenced crop types cultivated | 1 | 1 | 2 | 0 |
| 23 | I was compensated for the loss of my land | −2 | −1 | −1 | −2 |
| 11 | I feel cheated | 2 | 2 | 1 | 1 |
| 34 | All promises have been fulfilled | 0 | 0 | −1 | −2 |
| 29 | The wildlife habitat has increased | 0 | −2 | −1 | 0 |
| 12 | Local medication is adversely affected | 2 | 2 | 1 | 1 |
| 31 | The project has reduced rural poverty | −1 | 0 | −2 | 0 |
| 4 | Mostly, elites were employed by the project | −1 | −1 | −1 | 1 |
| 18 | Our social relationships have been interrupted | −1 | 1 | 1 | 1 |
| 26 | There is improved biodiversity | 1 | −2 | 1 | 0 |
| 15 | The project failed to serve our interest | −2 | 0 | 1 | −1 |
| 14 | There are jatropha poisoning of livestock | −2 | −1 | 0 | −1 |
| 16 | The biofuel project made me poorer | −1 | 0 | 1 | −1 |
| 30 | Our chief gave out land in our interest | 0 | 1 | −2 | 0 |
| 13 | Medical herbs/trees have been cleared | 1 | 2 | 0 | 1 |
| 17 | There is increased forest area | −1 | 1 | 2 | 0 |
| 6 | The project has better future for the community | −1 | 0 | 0 | 2 |
| 20 | Loss of aesthetic landscape | −1 | 1 | 0 | −1 |
| 21 | There is decreased grazing area | 0 | 1 | −1 | −2 |
| 19 | The government should take back our land | 0 | 0 | 2 | 0 |
| 3 | There are increased employment opportunities | 1 | −1 | 0 | 2 |
| 28 | Improved overall environmental quality | 0 | −2 | 0 | 2 |
| 8 | The investors should expand the project | 1 | −1 | −1 | 2 |
| 22 | Increased water pollution | −1 | 2 | −1 | −2 |
| 5 | Technology/new ideas have been introduced | 1 | −2 | 2 | 2 |
| 7 | There is enhanced community status | 2 | 1 | −2 | 2 |
| 9 | The investors are concerned with our welfare | 2 | 0 | −2 | 1 |
| 1 | Your farming practices have been influenced | 2 | −1 | 2 | −1 |

## Data availability

Data available in Mendeley Data

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## Appendix A. Appendices

Tables 13, 14.

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