# Underlying Constructs of Small-Holder Farmers' Perceptions and Attitude towards Improved Maize Technology in Bawku West District of Ghana
https://dx.doi.org/10.4314/jae.v23i3.1

**John, Abugri Akumbole**
Department of Agricultural Extension, Rural Development & Gender Studies
Faculty of Agribusiness & Communication Sciences
University for Development Studies, Tamale- Nyankpala Campus, Ghana.
Email: akumbole@gmail.com, Phone: (+233) (0)200935961

**Hudu, Zakaria**
Department of Agricultural Extension, Rural Development & Gender Studies
Faculty of Agribusiness & Communication Sciences
University for Development Studies, Tamale- Nyankpala Campus, Ghana. Email:
azakariahudu@gmail.com Phone: (+233) (0)242980581

**Hamza, Adam**
Department of Agricultural Extension, Rural Development & Gender Studies
Faculty of Agribusiness & Communication Sciences
University for Development Studies, Tamale- Nyankpala Campus Ghana. Email:
hamzeet@yahoo.com, Phone: (+233) (0)541997998

## Abstract

*The study analysed farmers' perceptions and attitudes towards improved maize technology among smallholder maize farmers in the Bawku West District of the Upper East Region of Ghana. Exploratory survey design was employed with multi-stage sampling techniques in sampling 400 maize farmers. Semi-structured questionnaire, observations, and focus group discussions were the main methods employed in data collection. Also Q – methodological process was employed in gathering farmers' narratives on improved maize technology. Exploratory Factor analysis was employed to examine the underlying constructs characterizing farmers' perception towards improved maize technology. The results identified six factors as the underlying constructs characterizing farmers' perceptions towards improved maize technology. These factors were inaccessibility issues, inappropriateness of some production recommendations, complexity and incompatibility of production recommendations, cost and affordability issues and poor capacity of farmers to adopt improved technologies. Farmer education on improved maize technologies should be intensified by the department of agriculture in the district to help build the capacity of farmers and inculcate in them positive attitude towards the production recommendations in the improved maize technology package.*

**Key words**: perceptions, attitude, constructs, improved maize technology and Q-methodology

## Introduction

Agriculture in Ghana is largely a rural based economic activity and mainly undertaken by smallholder farmers deploying rudimentary technologies in producing most (80%) of the country's agriculture products (Ministry of Food and Agriculture (MOFA), 2012 & Ghana Statistical Service (GSS), 2016). Agriculture sector's contribution to Ghana's Gross Domestic Product (GDP) had witnessed consistent decline in recent times, dropping from 31.8% in 2009 to 20.3% in 2016 (GOG, 2017 & GSS, 2016). Similar trends have been observed regarding agricultural sector's growth rate, showing steady decline from 7.2% in 2009 to 3.0% in 2016 (GSS, 2018). This phenomenon is worrying considering the fact that agriculture still remains the largest source of employment in Ghana (MOFA, 2012 & 2016) and it expected to play a critical role in poverty reduction and wealth generation.

Low technology adoption by smallholder farmers coupled with low level of investment into the agricultural sector as well as undeveloped agricultural market and commodity value chain system have been largely blamed for the general stagnation and low productivity Ghana's agricultural sector is currently experiencing (GSS 2018).

Maize, being one of the major staple crops in Ghana, has received extensive research and development attention culminating in the development of improved varieties, best technologies and farming practices (Ragasa *et al.*, 2013). Maize is Ghana's most important cereal crop and it is grown by vast majority of rural households. It is widely consumed throughout the country, and it is the second most important staple food in Ghana, next to cassava (Ragasa et al., 2013 & MOFA, 2013).

Evidence available suggests that adoption of maize technologies among smallholders is limited (MOFA, 2012). The Ministry of Food and Agriculture (MOFA) through its extension directorate have been promoting the adoption of improved maize technologies such as improved seeds, best agronomic practices, use of fertilizer and post-harvest management, for over three decades now (Ragasa et al., 2013 & MOFA, 2016). However, actual yields of maize have been woefully below potential and attainable yields. As observed by Ragasa et al. (2013) yields of maize are generally less than half of economically attainable yields. For example, national average yields are 1.7 metric tons/hectare (MOFA, 2011), however, data from different on-station and on-farm trials suggest that achievable yields are between 4 to 6 tons/hectare (Ragasa *et al.*, 2013).

To bridge these huge yield deficits, research and extension efforts have been focused on promoting adoption of improved maize technologies as part of the country's agricultural modernization agenda. Notwithstanding, studies have identified the cause of low productivity of maize to low adoption of productivity-enhancing

technologies, including use of improved varieties, and recommended management practices, and low use of purchased inputs, especially fertilizer (Ragasa *et al.*, 2013 & MOFA, 2016).

Wisdom *et al.*, (2014) asserted that one reason why there is so much interest in the diffusion of innovations is because getting a new idea adopted, even when it has obvious advantages, is often very difficult, in spite of the fact that there is a wide gap in many fields, between what is known and what is actually put into use. The niche of the paper is that there is a dearth in knowledge in understanding the factors that account for low adoption of maize technologies. Studies (Akumbole, Zakaria & Adam, 2018; Fadare *et al.*, 2014; Ragasa *et al.*, 2013 & Salifu *et al.*, 2015) have concentrated largely on impacts of technology adoption on farm productivity without focusing on factors accounting for the low technology adoption by maize farmers. To this end, the present paper presents empirical information on a study conducted to examine farmers' perception and attitudes towards adoption of improved maize technology among maize farmers in the Bawku west District of the Upper East region of Ghana.

## Methodology

The study was conducted in the Bawku west District of the Upper Region. The Bawku West District is located within the north-eastern area of the Upper East Region and lies roughly between latitude $10^0$ 30'N and $11^0$ 10'N and between longitudes $0^0$ 20'E and $0^0$ (GIS, 2014). The District shares boundary to the North with the Province of Zabre in neighbouring Burkina Faso, to the East by the Binduri and Garu-Tempane Districts, to the West by the Talensi and Nabdam Districts respectively and to the South by the Mamprusi East District to the South.

DISTRICT MAP OF BAWKU WEST
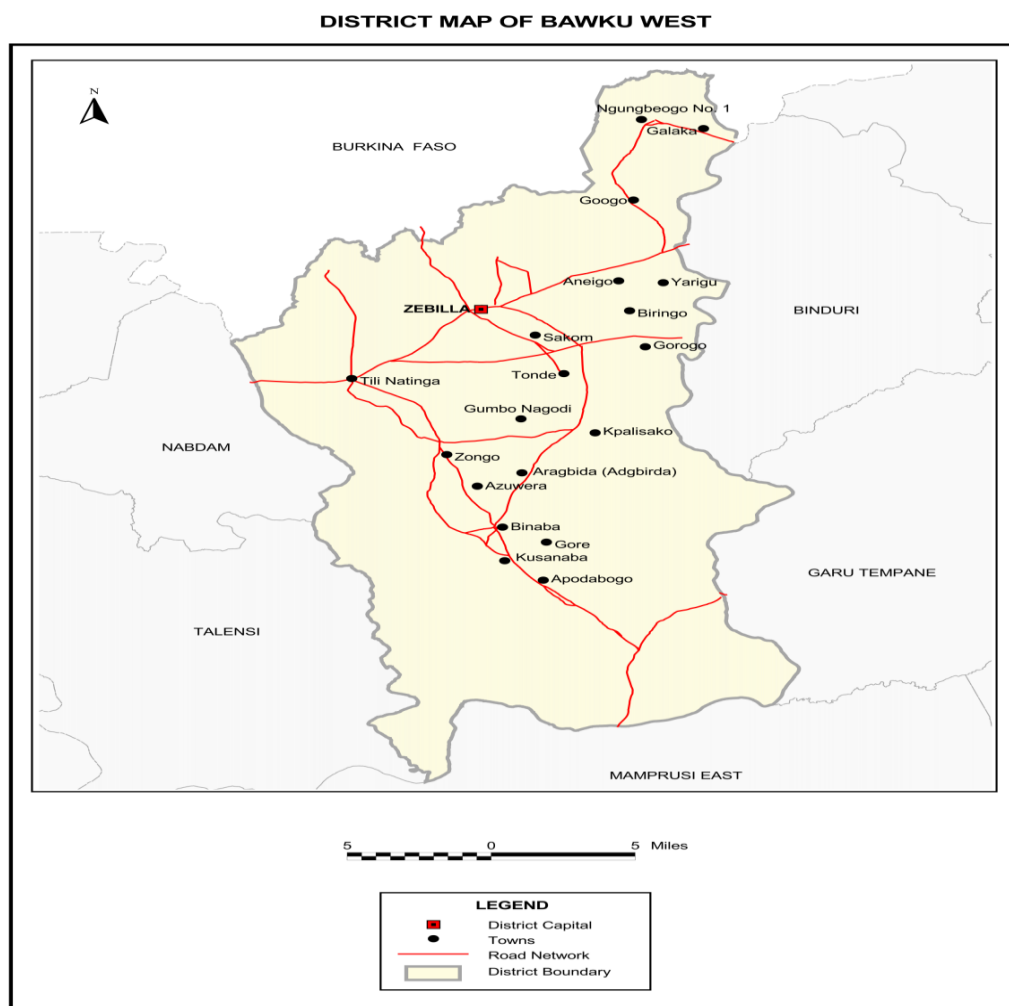
Source: GIS (2014)

## Population and Sample Size Determination

A List of 5,750 maize farmers in all the 24 operational areas in the district was sourced from the District Department of Agriculture and this constitutes the sampling framework from which the sample size was drawn. With the application of Cochran's sample size determination formula, 411 farmers were sampled. However, 11 farmers sampled could not be reached for interview. Therefore, the sample size used in the study was 400 maize farmers.

Multi-stage sampling procedure was employed in selecting respondents for this study. The District (Bawku West) was purposively selected because it is one of the leading maize producing districts in the upper east region. This was followed by stratified random sampling technique in which the district was stratified along the 24 MOFA operational areas. From the list of maize farmers introduced with the

improved maize technology, lottery method of simple random sampling technique was applied in sampling respondents from each operational area.

## Data collection methods

Questionnaires, focus group discussion, key informant and in-depth interviews were employed in collecting primary data. Secondary data were obtained from records sourced from the district department of agriculture, MOFA and NGOs working to promote technology transfer to farmers in the district.

In order to collect data on farmers' views, perceptions and general narrative regarding improved maize technologies, Q – mythological process was employed. Q study has a laid down systematic procedure of gathering discourse or narratives surrounding issue of interest. Watts and Stenner (2012) observed that Q study is a clearly structured, systematic, and increasingly used methodology in studying narratives, perspectives and viewpoints of an issue of interest. It therefore provides systematic methodology for researchers to explore distinct perspectives, discourses, or viewpoints within a group in order to address practical matters such as the acceptance of new policies and technology or issue of public concern.

## Data Analysis

With the aid of the IBM-SPSS Statistical Package mean and factor analysis were employed in analysing the data gathered. To examine the underlying constructs characterising farmers' perceptions towards improved maize technology exploratory factor analysis was applied on the wide range of narratives gathered from farmers. These narratives were constructed into 46 statements portraying arrays of views and perceptions expressed by the respondents. Respondents were then asked to rank the statements on a five points Likert type scale. Their rank score was then subjected to exploratory factor analysis as data reduction technique aimed at reducing the dimensions in the data set.

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted to establish the suitability of the dataset for factoring. To test the number of dimensions which adequately represent the constructs and structure in the dataset, Velicer's minimum Average Partial (MAP) test and parallel analysis were conducted. Also scree plot and percentage of variance explained by factors were used as guide to determining the suitable number of factors to extract Factor loadings below 0.4 were suppressed in order to have a clear factor interpretation and to clearly determine which variable is strongly loaded onto which factor.

Respondents' attitude towards improved maize technology was measured on a Likert-type scale. Likert-type agreement score has been widely used to measure individual attitude towards issues of interest to researchers. Five points Likert-type scale with '1 = strongly disagreed to 5 = strongly agreed'. To measure representative of view of farmers regarding each of the statements, descriptive statistics was

employed with one sample t-test applied to measure the representative of agreement mean score.

## Results and Discussion

As shown in Table 1, almost all the 400 farmers (95.8%) indicated that their household depends on on-farm livelihood activities for their living and income sources. This finding is similar to that of the sixth round Ghana Living Standard Survey (GLSS) conducted by Ghana Statistical Service (GSS), which indicated that most Ghanaians in the three northern regions depend on farm or agricultural related activities for their livelihoods (GSS, 2014a).

With female farmers playing critical role in agriculture in Ghana (MOFA, 2012) it was surprising that only a quarter (24.5%) of the maize farmers surveyed were females. The selection criteria used in this study could account for low level of female farmers captured in the study. In the study only farmers who have been introduced to the improved maize technology package either by the MOFA or NGOs working in the district were targeted for sampling.

The majority (51%) of the respondents surveyed in the study were within their youthful age (younger than 36 years), whiles about 45.3% were between the ages of 36 to 60 years, with only 2.5% being older than 60 years (see table 1). This is in sharp contrast to the findings of Ghana agricultural sector review report, which indicated that majority of Ghanaian farmer is above 40 years and that the youth are not going into farming (MOFA, 2016).

Regarding marital status, the analysis reveals that the overwhelming majority (87.5%) of the respondents were married. This finding differed from the district's results of the 2010 population and housing census. The census results indicates that about half (52.2%) of the population aged 12 years and older were married (GSS, 2014b).

Also, the majority (67.3%) of the maize farmers had no formal education, while 23.3% were educated to the basic level and 6.5% and 3% respectively having secondary and tertiary levels of education. Education has been noted as very critical in farmers' technology adoption and their ability to manage efficiently farming activities.

**Table 1: Farmers' demographic characteristics**

| Demographic Characteristics | Percent (%) |
| --- | --- |

| | | |
|---|---|---|
| **Sex** | Male | 75.3 |
| | Female | 24.8 |
| **Age category** | Younger than 25years | 5.6 |
| | 25 - 35 years | 45.3 |
| | 36 - 60 years | 46.5 |
| | 60+ years | 2.5 |
| **level of education** | No formal education | 67.3 |
| | Basic level | 23.3 |
| | Secondary | 6.5 |
| | Tertiary | 3.0 |
| **marital status** | Married | 87.5 |
| | Single | 8.0 |
| | Divorced | 2.3 |
| | Windowed | 2.3 |
| **Source of household income** | On-farm | 95.8 |
| | Off-farm | 4.2 |

**Source: Field data, 2016**

**Underlying Constructs of Farmers' Perception on Improved Technologies**
Table 2 presents results of distribution of factor loadings of items entered into exploratory factor analysis.

The dataset was found suitable for factor analysis, as shown in the Table 2, with KMO = 0.875 and Bartlett's test of sphericity being significant at 0.001 level ($\chi^2$ =24949.046; df = 946; p≤0.05). As shown in Table 2, one factor solution represents 39.7% of the dimension, while two and three factors solutions respectively added additional 11.7% and 7.9% in explaining the total variance explained. Six factor solutions cumulatively explained 72.5% of the total variance in the dataset. As such six factor solutions were retained.

As shown in Table 2, ten (10) statements were loaded onto factor one (1), eight (8) statements were loaded onto factor two (2), seven (7) statements on factor three (3) and another seven (7) statements on factor four (4). Also seven (7) statements were loaded to factor five (5) and five (5) statements on factor six (6). The factor labelling was based on the generality of the statements loaded onto them.

**Table 2: Distribution of factor loadings**

| Items | Factor Loading |
|---|---|
| **Factor 1 - Inaccessibility Issues: (variance explained = 39.7%**) | |
| I don't have access to weather information | 0.881* |

| | |
|---|---|
| poor accessibility of certified seeds | 0.882* |
| Lack of land is limiting my ability to engage in commercial farming | 0.881* |
| I don't have access to extension service | 0.872* |
| I can't afford mechanised Sheller to shell my maize | 0.741* |
| there is poor access to tractor services here | 0.732* |
| I lack access to labour for my farm operations | 0.661* |
| I lack appropriate maize harvesting tools/equipment | 0.572* |
| Poor access to market information is affecting maize pricing | 0.501* |
| I don't have access to credit to expand my farm | 0.492* |
| **Factor 2 - Inappropriate technology Issues: (variance explained = 11.7%)** | |
| I keep records because the banks ask for it any time i need a loan | 0.931* |
| I don't use chemicals to control weeds because i have been hearing they can destroy the soil | 0.872* |
| what I have been hearing about this certified seed is not good | 0.860* |
| I often relied on bullocks or bulls to plough my farm land | 0.770* |
| Lack of drying equipment is responsible for post-harvest losses of my maize | 0.702* |
| I am not sure the insurance companies will keep to their terms | -0.621* |
| I hardly encounter disasters so insurance is waste of money | 0.572* |
| I trust my own selected seeds than the certified seeds being sold | 0.451 |
| **Factor 3- Complexity issues: (variance explained = 7.9%)** | |
| It is difficult to follow recommended calibration and method of weedicide application | 0.941* |
| loans payment terms are highly unbearably | 0.902* |
| I have the requisite farm tools to implement the recommendation | 0.823* |
| recommended line planting and row spacing are difficult to practice | 0.694* |
| the consequences of defaulting a loan is too strict | 0.651* |
| recommended line planting and row spacing are time consuming practice | 0.652* |
| High labour demand for manual harvesting of maize makes it difficult to harvest on time | 0.591* |
| **Factor 4- Incompatibility Issues: (variance explained = 5.9%)** | |
| records are not important to me that is why i don't keep records | 0.871* |
| loans processes is very cumbersome | -0.722* |
| I don't normally keep farm records of my farm activities | 0.701* |
| mixed farming practices is the best to cope with on certainties in crop production | -0.702* |
| I always use manure from my livestock to fertilize my maize farm | -0.551* |
| keeping of livestock do not allow me to have enough time for my maize farm | 0.542* |
| the group mode of credit disbursement is not safe and suitable for me | 0.491* |
| **Factor 5 – Cost and affordability Issues: (variance explained = 4.4%)** | |
| I control weeds manually because I can't afford to buy weedicides | 0.851* |
| tractor service are expensive and beyond what I can afford | 0.830* |
| the premium for crop insurance policy is too high | 0.801* |
| I don't use the tractor to thrash because i cannot afford to pay | 0.741* |
| The profit margin of maize does not encourage me to go into commercial production | 0.692* |
| certified seed is very expensive and beyond what I can afford | 0.633* |
| record keeping comes at a cost and I cannot afford it | 0.531* |
| **Factor 6 - Poor capacity Issues: (variance explained = 2.9%)** | |
| I don't know how to apply chemical weedicide myself | 0.921* |
| I don't fully understand the concept of crop insurance | 0.572* |
| certified seed growers always deceive us to buy their seeds | 0.763* |
| I find it difficult to understand and practice calibration for spraying | 0.774* |
| there is poor marketing opportunities for maize | 0.491* |

Extraction Method: Principal Axis Factoring.Rotation Method: Varimax with Kaiser Normalization.
*P≤ 0.05
Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.875
Bartlett's Test of Sphericity: Chi-Square (df = 946) = 24949.046: Sig. = .000
Cumulative % of variance explained by the three factors = 72.513%
**Source: Field data, 2016**

The entirety of statements loaded on factor one suggests accessibility of information and inputs required in the adoption of the production recommendations in the package of the improved maize technology. Statements

such as 'I don't have access to weather information (0.881)', 'poor accessibility of certified seeds (0.882)' and 'I don't have access to extension service (0.872)' among others were all loaded onto factor one. As such factor one was labelled as '**inaccessibility issues**'.

Also, statements such as 'I keep records because the banks ask for it any time I need a loan (0.931)', 'what I have been hearing about this certified seed is not good (0.860)', 'I am not sure the insurance companies will keep to their terms (-0.621)', 'I hardly encounter disasters so insurance is waste of money (0.572)' and 'I trust my own selected seeds than the certified seeds being sold (0.451)' among others were loaded onto factor two (2). Critical examination of the general import of all the statements indicates that respondents were wondering about the appropriateness of some of the production recommendations in the improved maize technology package. As such factor two (2) was labelled as 'Inappropriate technology' as perceived by farmers.

Similarly, the seven (7) statements loaded onto factor three portrayed farmers' perceptions about the complexity and difficulty nature of some of the production recommendations. Statements include 'It is difficult to follow recommended calibration and method of weedicide application (0.941)', 'recommended line planting and row spacing are difficult to practice (0.694)' and 'High labour demand for manual harvesting of maize makes it difficult to harvest on time (0.591)' were loaded onto factor three. As such factor three (3) was labelled as '**Complexity issues**'. Respondents were of the view that some of the production recommendations in the package of improved maize technology were too complex for them to apply. Row spacing, appropriate fertilizer application methods, calibration in weedicide application among others were mentioned as being too complex to apply.

For factor four (4), the import of the statements loaded onto it showed incompatibility nature of some of the production recommendations with farmers' practice. Statements such as 'records are not important to me that is why i don't keep records (0.871)', 'mixed farming practices is the best to cope with uncertainties in crop production (-0.702)' and 'the group mode of credit disbursement is not safe and suitable for me (0.491)' were loaded onto factor four. As such factor four was given the label '**incompatibility issues**'. Thus the generality of the statements loaded on this factor borders on the fact that some of the production recommendations do not fit into smallholder farmers' farming system and as such making it difficult for them to adopt. Farmers surveyed were not familiar with raw spacing and use of purchased certified seeds. Farmers in the study area are used to the tradition of selecting, storing and preserving their own seeds for reuse in the next season. Broadcasting dip and burying of seeds are the most widely method of planting maize in the study. Notwithstanding the fact that in terms of yield, use of certified seeds of improved varieties of maize have been shown to be significantly superior to farmers' selected seeds, (Akumbole *et al.*, 2018; Fadare *et al.*, 2014; Ragasa et al., 2013 & Salifu et al., 2015) some farmers in the study areas still relied on their own selected seeds for planting. For factor five (5) seven statements were loaded onto it as shown in the Table 2. The generality of the statements loaded onto factor five portrayed issues of

cost, affordability and resource required in undertaking the production recommendations. Some of the statements include 'I control weeds manually because I can't afford to buy weedicides (0.851)', 'tractor service is expensive and beyond what I can afford (0.830)', 'certified seed is very expensive and beyond what I can afford (0.633)' and 'I don't use the tractor to thrash because i cannot afford to pay (0.741)'. As such, factor five was labelled as '**cost and affordability issues'**. This construct portrays farmers' concerns regarding cost of purchase inputs mostly chemical fertilizer, weedicide, certified seeds and mechanized services. In spite of government subsidy on chemical fertilizer and weedicide, cost of these critical inputs in maize production keep on increasing making it difficult for farmers to purchase the require quantities and apply the recommended rate.

Factor six (6) have statements such as 'I don't know how to apply chemical weedicide myself (0.921)', 'I don't fully understand the concept of crop insurance (0.572)' and 'I find it difficult to understand and practice calibration for spraying (0.774)' among others, loaded onto it. All these statements portrayed issues of individual farmer's capacity to understand and adopt production recommendations in the package of improved maize technology being disseminated among maize farmers in the District. As such factor six was labelled as '**Poor capacity  issues'**.

In general, maize farmers surveyed were concerned with what they perceived as inaccessibility of some certified seeds and other inputs and information needed to adopt the improved maize technology. They were also concerned about the difficulties and complexities of implementing some of the production recommendations such as planting in line at the recommended distance, applying fertilizer at the recommended rate and time among others. Farmers perceived some of the production recommendations as inappropriate in their case because they lack appropriate farming tools to enable them apply the production recommendations accurately. There were also concerns about the cost of some of the inputs required to implement the production recommendations. They perceived the cost of certified and improved seeds, fertilizer and tractor services as too high.


**Inaccessibility issues**

Table 3 shows that  farmers' generally were in agreement with the statements such as 'there is poor access to tractor services here' with $\bar{x}$ = 4.4 ±1.4; t = 35; 'I don't have access to credit to expand my farm' ( $\bar{x}$ = 4.1±0.7; t = 119.1); 'I lack appropriate maize harvesting tools/equipment' ($\bar{x}$ = 3.7±1.5; t = 50.3); 'I  lack access to labour for my farm operations' ($\bar{x}$ = 4.3 ± 1.3; t = 33.9) and 'Poor access to market information is affecting maize pricing ' ($\bar{x}$ = 4.2 ± 1.1; t = 78). They were also concerned about the lack of access to weather information. These perceptions of farmers are well grounded in available facts as uncovered in the ministry of food agriculture review of performance of agricultural sector performance. The review report identified poor access to credit and low level of mechanization as the main challenge facing Ghana's agriculture (MOFA, 2016).

Farmers' concerns regarding accessing tractors services stemmed from limited number of tractors and unavailability of mechanization centre in the district. Tractors services in the district are provided by medium-scale farmers who owned tractors. These farmers after ploughing their lands provide tractor services to fellow farmers for a fee. Smallholders' use of hired-tractor services is quite high in the district. Houssou *et al.* (2017) in their study on emergence of hired-tractor services in Ghana concluded that availability of hired-tractor services significantly increases the rate of tractor use in ploughing and other farm operations by smallholder farmers.

However, respondents were not in agreement that they have been unable to expand their farms due to lack of access to land. As shown in the Table 3, respondents generally disagreed with the statements 'I don't have access to extension service' ($\bar{x}$ =2.3 ± 1.4; t = 32.9), ' I can't afford  mechanised Sheller to shell my maize ' ($\bar{x}$ = 2.3±1.6; t = 42.1) and 'Lack of access to land is limiting my ability to engage in commercial farming' ($\bar{x}$ =2.2 ± 1.7; t = 30.9). Thus land was not a limiting factor preventing smallholder farmers in the study area from engaging in medium and large – scale farming. The district has vast arable land with soil suitable for cereal cultivation (District Department of Agriculture, 2017). The district constituted 12% of the total land area of the Upper East Region making it the fifth largest district in the region. The total cultivable land area of the district is 58,406ha and uncultivable area of 33,687 (MOFA, 2017). It is therefore clear that the district still has a virgin arable land for farmers to expand their farms.

Issues of accessibility of agricultural information have been cited in literature as one of the constraining factors in technology adoption (Fadare *et al.*, 2014 and Salifu *et al.*, 2015).  Farmers in Ghana have long lamented the unavailability and accessibility of certified seeds of improved maize varieties because of limited certified seed growers in the country. The poor extension officer to farmer ratio coupled with lack of innovativeness in agricultural extension service delivery (MOFA, 2012; 2016), have further worsen farmers access to information on certified seeds and other agricultural inputs.

**Table 3:  Agreement in rank scores on farmers' inaccessibility issues**

| Statement | Mean ($\bar{X}$) ± SD | t |
|---|---|---|
| poor accessibility of certified seeds | 2.8+1.6 | 34.9* |
| there is poor access to tractor services here | 4.4+1.4 | 35.0* |

| | | |
|---|---|---|
| I don't have access to credit to expand my farm | 4.1±0.7 | 119.1* |
| I lack appropriate maize harvesting tools/equipment | 3.7±1.5 | 50.3* |
| I can't afford mechanised Sheller to shell my maize | 2.3±1.6 | 42.1* |
| I don't have access to extension service | 2.3±1.4 | 32.9* |
| I lack access to labour for my farm operations | 4.3±1.3 | 33.9* |
| I don't have access to weather information | 2.8±1.3 | 43.4* |
| Lack of land is limiting my ability to engage in commercial farming | 2.2±1.7 | 30.9* |
| Poor access to market information is affecting maize pricing | 4.2±1.1 | 78.0* |

*$P \leq 0.05$. **Source: Field data, 2016**

**Complexity issues**

Respondents generally agreed with the statements 'recommended line planting and row spacing are difficult to practice' ($\overline{x}$ = 3.9± 1.1; t = 70.1), 'recommended line planting and row spacing are time consuming practice' ($\overline{x}$ = 4.1 ± 1.2; t = 69.9) and 'High labour demand for manual harvesting of maize makes it difficult to harvest on time' ($\overline{x}$ = 3.8 ± 1.3; t = 58.6) (Table 4).The results thus demonstrate respondents' agreement with the perception that it is difficult and complex to comply with the recommended row spacing and that the improved maize technology is labour demanding, making it difficult to practice. Such perceptions are bound to have a negative effect on farmers' adoption of row spacing. Farmers in the study area were not used to sowing their maize in line using calibrated rope and tape measure which have been designed for them by extension officers to enable them follow the recommended within and between row sowing. Following recommended row spacing of sowing maize have been proven to have positive effect on nutrient use efficiency and yield (Fahad et al., 2016).

**Table 4: Rank score on complexity issues**

| Statement | Mean ($\overline{X}$) ± SD | t |
|---|---|---|
| recommended line planting and row spacing are difficult to practice | 3.9 ± 1.1 | 70.1* |

| | | |
|---|---|---|
| recommended line planting and row spacing are time consuming practice | 4.1 ± 1.2 | 69.9* |
| I have the requisite farm tools to implement the recommendation | 2.2 ± 1.7 | 31.2* |
| loans payment terms are highly unbearably | 2.8 ± 1.5 | 33.2* |
| the consequences of defaulting a loan is too strict | 2.7 ± 1.3 | 43.5* |
| It is difficult to follow recommended calibration and method of weedicide application | 2.7 ± 1.7 | 31.3* |
| High labour demand for manual harvesting of maize makes it difficult to harvest on time | 3.8± 1.3 | 58.6* |

*P≤0.05. **Source: Field data, 2016**

But, they generally disagreed with the statement that 'I have the requisite farm tools to implement the recommendation' ($\overline{x}$ = 2.2 ± 1.7; t = 31.2), indicating that farmers were of the view that they lack the needed farm tools to effectively implement the production recommendations in the package of the improved maize technology. Some of the tools required were simple farm tools such as tape measure, planting rope, and maize hand held harvester amongst others. But farmers in the study area were not used to them they prefer using their traditional tools in undertaking their farming activities.

Perceived ease of use, which depends on how complex a technology is, had been demonstrated to have a significant effect on its acceptability and adoption. Two factors namely, perceived usefulness and perceived ease of use is critical in determining individual technology acceptance (Lai, 2017 & Wisdom *et al.*, 2014). Lai (2017) defines perceived ease of use as the degree to which the prospective user expects the target system to be free of effort. Therefore, if farmers perceived any of the production recommendations within the package of improved maize technology to be difficult they would be less likely to accept the practice.

Planting in line and proper row spacing, appropriate method of fertilizer application and weedicide calibration were noted as difficult tasks in following the maize production recommendations. A participant at one of the focus group discussion observed that '*some of the things the agriculture people are telling us to do are very difficult and we cannot follow it fully…*' (Verbatim comments of a participant).

**Incompatibility Issues**

As shown in the Table 5, respondents in general agreed with the statements 'the group mode of credit disbursement is not safe and suitable for me' ($\overline{x}$ = 4.1± 1.2; t = 68.6) and 'loan process is very cumbersome' ($\overline{x}$ = 3.7 ± 1.6; t = 40.9). This indicates

that farmers in general are not satisfied with credit mode of application and terms and condition of disbursement. Application of some of the production recommendations required the use of purchase inputs such as chemical fertilizer, weedicide and certified seeds. Therefore, farmers' access to credit is important as it would enable them purchase these inputs. According to Abdallah (2016), availability and access to credit positively affect farmers' production efficiency as they are able to undertake investment in technologies.

Farmers in the study area sourced loans from both formal and informal sources mainly from rural bank, microfinance institutions and local money lenders. At the various focus group discussions participants generally were of the view that they lack access to formal sources of credit and where condition of disbursement coupled with high interest rates makes it difficult for smallholder farmers to access. Therefore, farmers in the study area relied largely on informal sources of credit mainly from money lenders, inputs dealers and traders in raising capital to purchase agrochemicals required in growing their maize. Lack of access to agricultural credit from formal financial sector such as banks had often been cited

They however, disagreed with the statements that 'keeping of livestock do not allow me to have enough time for my maize farm' ($\bar{x}$ = 1.9 ± 1.2; t = 31.3) and 'records are not important to me that is why I don't keep records' ($\bar{x}$ = 2.2 ± 1.5; t = 34.7). They could not however, express any opinion on the statements that 'mixed farming practices is the best to cope with uncertainties in crop production' ($\bar{x}$ = 2.7 ± 1.5; t = 36.6), 'I always use manure from my livestock to fertilize my maize farm' ($\bar{x}$ = 3.4 ± 1.5; t = 45.8) and 'I don't normally keep farm records of my farm activities' ($\bar{x}$ = 2.7 ± 1.8; t = 34.7). That farmers are undecided regarding the view that mixed farming practices is the best way of dealing with uncertainty in farming and that farmers always used animal manure to fertilizer their farms.

The perception of farmers not attaching importance to record keeping was emphasized at the various focus group discussions held. In such discussions most of the participants indicated that they do not keep records of their farm activities. A participant at one of the focus group discussion lamented '*I cannot read nor write how can I keep records and what use will it be for me*?' (Verbatim comments of a participant). Analysis of their response to a follow-up question of why they do not keep records revealed two main reasons – illiteracy (most of them could neither read nor write) and 'they do not see the importance of record keep'. This compares fairly well with earlier studies. Dudafai (2013) opined that smallholder farmers in Ghana hardly keep records of their farm activities because they underrate its importance.

Being largely subsistence farmers most of the respondents do not produce for the market but rather engage in farming to feed their households and only sell the surplus if any. As such the motive is not for profit. This could explain why they do not attach much importance to record keeping and keeping track of their investment.

**Table 5: Scores on incompatibility issues**

| Statement | Mean ($\overline{x}$) ± SD (Max =5) | t |
|---|---|---|
| the group mode of credit disbursement is not safe and suitable for me | 4.1±1.2 | 68.6* |
| loans processes is very cumbersome | 3.7±1.6 | 40.9* |
| mixed farming practices is the best to cope with uncertainties in crop production | 2.7±1.5 | 36.6* |
| I always use manure from my livestock to fertilize my maize farm | 3.4±1.5 | 45.8* |
| keeping of livestock do not allow me to have enough time for my maize farm | 1.9±1.2 | 31.3* |
| I don't normally keep farm records of my farm activities | 2.7±1.8 | 30.6* |
| records are not important to me that is why I don't keep records | 2.2±1.5 | 34.7* |

*$P \le 0.05$. **Source: Field data, 2016**

**Issues of inappropriate technology**

As shown in the Table 6, respondents generally agreed with the statements 'I trust my own selected seeds than the certified seeds being sold' ($\overline{x}$ = 4.2 ± 1.0; t = 81.4), 'I hardly encounter disasters so insurance is waste of money' ($\overline{x}$ = 4.0 ± 0.9; t = 92.4) and 'I often relied on bullocks or bulls to plough my farm land' ($\overline{x}$ = 3.6 ± 1.4; t = 52.6). It is worrying that farmers have more trust in their own selected seeds than the certified seeds as this is bound to have negative effect on adoption of certified seed. In spite of significant improvement in seed regulation and marketing in Ghana (Tripp & Mensah-Bonsu, 2013), farmers surveyed still expressed this kind of reservations about the reliability of certified seed to extent that they trust their own selected and stored seeds than certified seeds. Also notwithstanding the recent outbreak of fall armyworms which affected cereals particularly maize farms throughout the country (Rwomushana et al., 2018) farmers surveyed still considered crop insurance as unimportance and superfluous. It is instructive that farmers generally were in agreement with the statement 'I hardly encounter disasters so insurance is waste of money, in spite of their recent experience with the fall armyworms devastation.

But, respondents in general disagreed with the statements 'I don't use chemicals to control weeds because I have been hearing they can destroy the soil' ($\overline{x}$ = 2.2 ± 1.5; t = 32.7) and 'Lack of drying equipment is responsible for post-harvest losses of my maize' ($\overline{x}$ = 2.3 ± 1.4; t = 35.3). They however, could not form opinion, on the

statements that 'what I have been hearing about this certified seed is not good' ($\bar{x}$ = 2.8 ± 1.7; t = 33.1), 'I am not sure the insurance companies will keep to their terms' ($\bar{x}$ = 2.6 ± 1.1; t = 47.7), and 'I keep records because the banks ask for it any time I need a loan' ($\bar{x}$ = 2.3 ± 1.6; t = 32.7). As shown by the mean agreement ranks on those statements above, respondents were undecided about them.

**Table 6: Scores on inappropriate technology Issues**

| Statement | Mean ($\bar{X}$) ± SD | t |
|---|---|---|
| I trust my own selected seeds than the certified seeds being sold | 4.2±1.0 | 81.4* |
| what I have been hearing about this certified seed is not good | 2.8±1.7 | 33.1* |
| I hardly encounter disasters so insurance is waste of money | 4.0±0.9 | 92.4* |
| I am not sure the insurance companies will keep to their terms | 2.6±1.1 | 47.7* |
| I often relied on bullocks or bulls to plough my farm land | 3.6±1.4 | 52.6* |
| I don't use chemicals to control weeds because I have been hearing they can destroy the soil | 2.2±1.5 | 32.7* |
| Lack of drying equipment is responsible for post-harvest losses of my maize | 2.3±1.4 | 35.3* |
| I keep records because the banks ask for it any time I need a loan | 2.3±1.6 | 32.7* |

*P≤0.05. **Source: Field data, 2016**

**Poor capacity issues**

As shown in the Table 7, respondents agreed with the statement 'there is poor marketing opportunities for maize' ($\bar{x}$ = 3.8 ± 1.0; t = 73.4). Farmers surveyed in general were of the view that the existing marketing options and opportunities were not in their favour as smallholder farmers. This perception stemmed from their general lack of information on market opportunities in getting good price for their farm produce. Farmers in the study area sell their maize to middlemen who go around from community to community to buy directly from farmers. Because of the bad nature of roads linking the communities to urban centres in Bolgatanga – the regional capital and Bakwa, farmers are unable to transport their maize to the urban towns where prices are better. The only option they have is to sell to the middlemen who come to their communities, especially in market days. Information gathered from the various focus group discussions revealed that some farmers usually entered into contractual relationship with these middlemen by taking loan from them. Such farmers are therefore obliged to sell their produce to these middlemen. At a focus group discussion, a participant observed '*we usually borrowed monies from them (middlemen) to buy fertilizer so when they come to buy from us we cannot refuse them… sometimes the price they offer for our maize is so low but what can we do.*.'

However, analysis of respondents' agreement rank score shows general disagreement among respondents regarding the statement 'I find it difficult to understand and practice calibration for spraying' ($\overline{x}$ = 2.4 ± 1.5; t = 32.6) and 'I don't know how to apply chemical weedicide myself' ($\overline{x}$ = 2.3 ± 1.5; t = 33). As such respondents generally perceived themselves to be capable of understanding the calibration and application of chemical weedicide. As part of the dissemination of the improved maize technology, farmers training aimed at building their capacity to enable them correctly practice the production recommendation have been going alongside the dissemination process. However, they could not decide on the statements that 'certified seed growers always deceive us to buy their seeds', ($\overline{x}$ = 3.2 ± 2.8; t = 22.5) and 'I don't fully understand the concept of crop insurance' ($\overline{x}$ = 2.5 ± 1.3; t = 33). Thus farmers surveyed were not sure about the reliability of certified seeds and also lack the understanding of the concept of crop insurance. That despite being trained and educated on these production recommendations farmers still do not have full trust on use of certified seeds and also were yet to be convinced about the concept of crop insurance.

High level of literacy among rural farmers in northern Ghana (GSS, 2016) and poor extension contact (MOFA, 2016) negatively affect smallholder farmers' capacity building in terms of their skills and expertise in undertaking good agronomic practices. The high literacy rate among smallholder farmers in the study area limit their ability to source and access agricultural information to enable them improve their farming practice and productivity.

**Table 7: Scores on poor capacity   issues**

| Statement | Mean ($\overline{X}$) ± SD | t |
|---|---|---|
| certified seed growers always deceive us to buy their seeds | 3.2±2.8 | 22.5* |
| I find it difficult to understand and practice calibration for spraying | 2.4±1.5 | 32.6* |
| I don't fully understand the concept of crop insurance | 2.5±1.3 | 37.9* |

| | | |
|---|---|---|
| I don't know how to apply chemical weedicide myself | 2.3±1.5 | 33.0* |
| there is poor marketing opportunities for maize | 3.8±1.0 | 73.4* |

*P≤0.05. **Source: Field data, 2016??**

## Cost and Affordability Issues

As shown in the Table 8, respondents generally agreed with the statements that 'certified seed is very expensive and beyond what I can afford' ($\overline{x}$ = 4.1 ± 1.7; t = 47.6), 'I control weeds manually because I can't afford to buy weedicides' ($\overline{x}$ = 3.8 ± 1.0; t = 66.9) and 'I don't use the tractor to thrash because i cannot afford to pay' ($\overline{x}$ = 3.7 ± 1.3; t = 57.2). Thus respondents generally perceived cost of certified seeds, weedicide and tractor services to be too expensive for them to afford. Such view would have effect on their decision to apply such purchase inputs in their maize production.

The adoption of production recommendations in the package of the improved maize technology require the use of high external inputs such as fertilizer, weedicide, and improved seeds. Therefore, the issue of accessibility, cost and affordability has been the concern of smallholder farmers in the study area. Many of the farmers are resource poor and are unable to raise the needed capital to purchase the required inputs. As a result, some of the farmers do not follow the recommended rate of fertilizer application and also do not use certified seeds because they cannot afford those inputs. A farmer at one of the focus group discussions held observed that *'I know the quantity of fertilizer to apply per acre as we are told by the extension office but I do not follow it simply because I cannot buy the required bags of fertilizer for my entire maize farm*' (verbatim comments of a participant). Another participant lamented ''*how do you expected us to use more fertilizer and certified seeds when their prices keep on increasing every year but prices of our farm produce are always low.'.* (Verbatim comments of a participant). The implication of these arguments show that cost of technology affects their adoption.

Similar narratives were expressed by many of the participants. Also the poor nature of road networks in the rural areas constrained easy transportation of fertilizer. This affects fertilizer supplies in rural markets creating shortages and limiting farmers' access to this critical input required in maize production. Farmers' lack of access to credit coupled with increasing price of chemical fertilizer, weedicide and certified seeds further worsen the smallholder farmers' ability to uptake the improved maize technology.

Prices of chemical fertilizer is still high and continue to increase annually despite the reintroduction of fertilizer subsidy programme in 2008 in which government absorbed 50% of the market price of fertilizer sold in Ghanaian markets in line with the Abuja declaration on fertilizer use for Africa green revolution (Hill and Kirwan, 2015; Holden, 2018; Houssou, Andam and Collins, 2017). Asare (2018) identified limited supply of subsidized fertilizer at rural and remote area, smuggling, difficulties in

accessing coupons in required in purchasing subsidized and fluctuation of market price of fertilizer as challenges limiting smallholder farmers' access and use of subsidized fertilizers in their crop production. Interactions with extension officers providing agricultural information to farmers in the study area confirmed the difficulties smallholder farmers faced in accessing subsidized fertilizer and weedicide because of limited supply and high prices.

**Table 8: Agreement of rank on cost and affordability**

| Statement | Mean ($\bar{X}$) ± SD | t |
|---|---|---|
| certified seed is very expensive and beyond what I can afford | 4.1±1.7 | 47.6* |
| tractor service are expensive and beyond what i can afford | 2.6±1.5 | 36.3* |
| the premium for crop insurance policy is too high | 3.3±1.0 | 66.9* |
| I control weeds manually because I can't afford to buy weedicides | 3.8±1.3 | 58.0* |
| I don't use the tractor to thrash because i cannot afford to pay | 3.7±1.3 | 55.6* |
| record keeping comes at a cost and I cannot afford it | 3.7±1.3 | 57.2* |
| The profit margin of maize does not encourage me to go into commercial production | 3.9±1.3 | 59.9* |

*$P \leq 0.05$.
**Source: Field data, 2016**

**Conclusion and Recommendations**

Smallholder farmers in general perceived some of the maize production recommendations to be complex and difficult to apply. They also felt that some of the production recommendations were inappropriate and incompatible with their farming system. As a result, they were of the view that they lack the capacity and the needed farm tools and equipment to correctly follow the production recommendations. Farmers also held the view that applying some of the production recommendations come at high cost and issue of affordability limit their ability to apply them. Farmer education on improved maize technology should be intensified by the department of agriculture in the district to help build the capacity of farmers and inculcate on them positive attitude towards the production recommendations in the improved maize technology package. Extension officers should facilitate linkage between farmers and agro-input dealers through value chain development to ensure farmers' access to agro –inputs.

**Reference**

Abdallah, A. (2016), "Does credit market inefficiency affect technology adoption? Evidence from Sub-Saharan Africa", *Agricultural Finance Review,* Vol. 76 No. 4, pp. 494-511.

Adam H, Zakaria H and Abujaja AM (2014). Sociocultural implications on innovation adoption: the case of adoption of yam minisett technology among farmers in Northern Region, *Ghana. Journal of Agricultural Economics, Extension and Rural Development*: Vol. 1(7): pp 105-113, July, 2014.

Akumbole JA, Zakaria H and Adam H (2018). Determinants of Adoption of Improved Maize Technology among Smallholder Maize Farmers in the Bawku West District of the Upper East Region of Ghana. Agricultural Extension Journal 2018; 2(3):165-175.

Asare K. Y. (2018). Non-farm livelihood diversification in selected rural and peri-urban communities in the Sunyani west district (Doctoral dissertation, University of Cape Coast).

District Department of Agriculture (2017). Bawku West District Profile. Bawku West District Department of Agriculture, Zebilla

Dudafa U.J (2013). Record Keeping Among Small Farmers in Nigeria: Problems and Prospects. International Journal of Scientific Research in Education, 6(2), 214-220

Fadare O. A., Akerele D and Toritseju B. (2014). Factors Influencing Adoption Decisions of Maize Farmers in Nigeria. International Journal of Food and Agricultural Economics. Vol. 2 No. 3 pp. 45-54

Fahad S, Saud S, Muhammad H, Hassan S, Shah A and Ullah F (2016). Effect of Row Spacing and Methods of Sowing on the Performance of Maize. Austin Food Sci. 2016; 1(2): 1008.

Ghana of Ghana (GOG) (2017). The Budget Statement and Economic Policy of the Government of Ghana for the 2017 Financial Year presented to Ghana Parliament. Government of Ghana (GOG), Accra.

Geographic Information System (GIS) (2014). Map of Bawku West District of the Upper East Region. Geographic Information, Ghana, Accra.

Ghana Statistical Service (GSS) (2018). Provisional 2017 Annual Gross Domestic Product. Ghana Statistical Service (GSS) GOG, Accra, April, 2018.

GSS (2014a). Ghana Living Standard Survey Round Six. Ghana Statistical Services, August, 2014, Accra.

GSS (2014b). 2010 Population and Housing Census, District Analytical Report, Bawku West District. Ghana Statistical Service, GOG, Accra.

GSS (2016). 2015 Ghana Labour Force Report, Ghana Statistical Service (GSS). GOG, Accra.

Hill, A., & Kirwan, B. (2015). Maize Response to Inorganic Fertilizer Use by Farmers in Ghana.

Holden, S. T. (2018). Fertilizer and sustainable intensification in Sub-Saharan Africa. Global food security, 18, 20-26.

Houssou, N., Andam, K. S., & Collins, A. A. (2017). Can better targeting improve the effectiveness of Ghana's Fertilizer Subsidy Program? (Vol. 1605). Intl Food Policy Res Inst

Jolliffe I (2014). Principal Component Analysis. Wiley Stats Ref: Statistics Reference Online, 2014.

Lai P.C (2017).  The literature review of technology adoption models and theories for the novelty technology.  Journal of Information Systems and Technology Management.  Vol. 14, No. 1, Jan/Apr., 2017 pp. 21-38.

Ministry of Food and Agriculture (MOFA) (2017). Bawku West. MOFA, Government of Ghana, Accra. Available at:  http://mofa.gov.gh/site/?page_id=1644 (retrieved on 20/12/2016).

Ministry of Food and Agriculture (MOFA) (2016). Agricultural Sector Progress Report 2015. Ministry of Food and Agriculture (MOFA), GOG, Accra.

Ministry of Food and Agriculture (MOFA) (2012). Performance of the Agricultural Sector in Ghana: 2006-2012. Gross Domestic Product (GDP) At 2006 Prices by Economic Activity: 2006-2012. Ministry of Food and Agriculture (MOFA), GOG, Accra.

Ministry of Food and Agriculture (MOFA) (2011). "Agriculture in Ghana: Facts and Figures (2010)." Statistics, Research, and Information Directorate. Accra, Ghana

Rwomushana, I., Bateman, M., Beale, T., Beseh, P., Cameron, K., Chiluba, M., Clottey, V., Davis, T., Day, R., Early, R., Godwin, J., Gonzalez-Moreno, P., Kansiime, M., Kenis, M., Makale, F., Mugambi, I., Murphy, S., Nunda. W., Phiri, N., Pratt, C., Tambo, J (2018). Fall armyworm: impacts and implications for Africa; Evidence Note Update, October 2018. CABI, UK.

Salifu H. and Salifu K (2015).  Determinants of Farmers Adoption of Improved Maize Varieties in the Wa Municipality. American International Journal of Contemporary Research. Vol. 5, No. 4; August 2015.

Tripp R and Mensah-Bonsu A (2013). Ghana's commercial seed sector: New incentives or continued complacency? GSSP Working Paper 32. Washington, D.C.: International Food Policy Research Institute (IFPRI).

Watts Simon and Paul Stenner  (2012). Doing Q Methodological Research Theory, Method & Interpretation. 248 pages SAGE Publications Ltd.

Wisdom, J.P., Chor, K.H.B., Hoagwood, K.E. et al. Adm Policy Ment Health (2014) 41: 480.

Ragasa C, Dankyi A, Acheampong P, Wiredu A.N., Chapoto A, Asamoah M, and Tripp R (2013). Patterns of Adoption of Improved Maize Technologies in Ghana. International Food Policy Research Institute IFPRI Working Paper 36| July 2013.