Knowledge and Perception of Farmers towards Genetically Modified Crops: The Perspective of Farmer Based Organizations in Northern Region of Ghana

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ABSTRACT

Despite the fact that Ghana had put in place legislative and institutional frameworks to guide the application of GMO technology in commercial agriculture, the desired results will not be realised unless farmers' knowledge and perception about GM crops are known and adequately addressed. This paper therefore, presents results of a survey assessing the knowledge and perception of 305 leaders of Farmer Based Organizations (FBOs) in Northern Region of Ghana towards GM crops. Q methodology was employed in guiding data collection process, with Likert Scale used in measuring farmers' perception; and descriptive statistics used in analysing the data. The study revealed that Majority of Leaders of FBOs are aware of GM crops, with close to two-third (64%) of those who are aware of it, having appreciable knowledge about the technology. While respondents were of the opinion that commercial application of agro biotechnology will help boost the country's food security situation, they were however, concerns about possible policy failures, environmental, health and market risks associated with GM crops cultivation. It is therefore recommended that relevant institutions should engage FBOs and streamline their information dissemination mechanism on GM crops to avoid misinformation and help boost farmers' confidence on the country's agro biotechnology agenda.

Key Words:

Perception, Knowledge, GM Crop, GMO Technology, Biosafety Act and FBOs

1. INTRODUCTION

Advances in the world economy and the overall wellbeing of humanity in general, are largely driven by and in fact, indispensable on advances in Science and Technology. Notwithstanding, however, most end users of technology, especially those in the agricultural sector hardly know anything about advancement in science and technology. As such, they are sometime unable to drive the maximum benefits from such technological advances. Agriculture, arguable is one of the areas of human endeavour whose development have benefited immensely from advances made in science and technology. Inspite of the gain agricultural production had made and continues to benefit through application of science and technology in crop and animal production, there had been some opposition in the application of certain scientific technologies in the field of agriculture. Genetically Modified Organisms (GMO) technology is perhaps the most vociferous contemporarily scientific advances which had received strong opposition in its application in agriculture (see Hanrahan 2010; Legge and Durant, 2010 and Bonny, 2003).

Key personalities such as Former UN Secretary General, Kofi Annan have had occasion to raise concerns about the appropriateness of GMOs application in African agriculture. On his appointment as the Chair of the Board of Directors of AGRA, he said "We in the alliance will not incorporate GMOs in our programmes. We shall work with farmers using traditional seeds known to them." Going further, Annan said "poor pricing of commodities and not type of seeds, keeps African growers away from their farmlands despite spiralling food insecurity and poverty on the continent" and that "insufficient infrastructure such as roads, poor storage facilities and weak market structures were to blame for Africa's continued dependence on food aid" Odhiambo,(2007.)

Crop varieties have long been subject to steady improvement by selection of better-performing varieties. The process of selecting better or desire traits of crops and plants in general, saw a further improvement through the application of Mendel's principles of genetics which culminated in scientific plant breeding process in the last century (Baulcombe, Dunwell, Jones, Pickett and Puigdomenech, 2014). Since then, Increasing advances in conventional plant breeding have continue to widen the range of improved crop varieties to help eliminate certain inherent attributes of crops which limit its productivity such as disease and pest susceptibility, low yielding, short shelve life among others. The emergency of Genetic Engineering leading to the creation of Genetically Modified Organisms, have made breakthrough in crop breeding overcoming inherent biological limitations to conventional plant breeding (James, 2012).

Ghana is set to adopt the Genetically Modified Organism (GMO) technology to improve agricultural production and income for farmers. The Ministry of Food Agriculture contended that reports by experts testified that GMO products were safe and there is therefore the need to put in place the necessary infrastructure to begin its (GMO) commercialization in the country (Ashitey, 2013). With the passage of the Biosafety and Biotechnology Law (Biosafety Act, 2011), Ghana had no option but to adopt the GMO innovation to enhance agricultural production through scientific methods as observed by Dr Joe Oteng-Adjei, Minister for Environment, Science, Technology and Innovation (Ghana Business News, 2011). Ghanaian parliament is currently considering Plant Breeders' Protection Bill to put in place legislative framework and process of guiding application of genetically engineering in plant breeding and safeguarding intellectual property of plant breeders. All these are preparatory processes of laying down legal framework to enable the country adopt commercial cultivation of GM crops and marketing of GMO products. GM technology had made important positive socioeconomic and environmental contributions. The major impact has been on commercialized agronomic traits in a small range of crops (Kenneth, 2011).

As Ghana lingers in its move to adopt commercial cultivation of GM crops, global acreage of GM crops continues to increase in its second decade of commercialization. Brooks and Barfoot, (2011) reported that, on the global scale the area planted with genetically modified crops has increased substantially over the past decade. They observed that, at 2009, about 14 million farmers worldwide planted GM crops on approximately 134 million ha with close to half (46%) of which was in developing countries. Earlier, James, (2008) indicated that developing countries noticeable, Argentina, Brazil, China, India, and South Africa contributed approximately 40% of the global total or 46 million ha in 2008. More recent statistics from ISAAA, (2014)

indicate that, the global hectarage of biotech crops have increased more than 100-fold. Moving from 1.7 million hectares in 1996 to over 175 million hectares in 2013, making GM crops the fastest adopted crop technology in contemporary history.

Farmers' role in effective implementation of any agricultural policy and technology cannot be over emphaised. But often time, in most developing country including Ghana, their participation in agricultural policy planning leave much to be desired (see Nxumalo and Oladele, 2013; Aref 2011 and Iqbal, 2007). Despite the proven numerous benefits associated with biotechnology (Baulcombe, et al, 2014 and James, 2012) the prospects of its adoption by Ghanaian farmers is largely depend on stakeholders', especially farmers, knowledge and perception about the technology. However, many studies which examined public perception towards GMO products often failed to assess farmers' knowledge and perception towards the adoption of GM crops. A study by Robert, Yawson, Wilhelmina, Irene & Ivy, (2008) on the 'Stakeholder Approach to Investigating Public Perception and Attitudes towards Agricultural Biotechnology in Ghana' failed to include farmers, an important stakeholder in the application of agro biotechnology. As a results very little empirical information about farmers' knowledge and perception about agricultural biotechnology exist in available literature in the country. As the debate on application of GMO technology in commercial agriculture intensified in the country, it is appropriate that information about farmers' knowledge and perception concerning GM Crops be made available to policy makers and implementers of agricultural policies. This paper therefore discussed results of research conducted to assess leaders of farmer based organizations in northern region knowledge and perception about GM crops as the nation set to embark on full commercial application of agro biotechnology.

2. RESEARCH METHODOLOGY

The field survey which generated data for this paper was collected over a period of four months in the twenty six Districts of the Northern Region of Ghana. The region which occupies an area of about 70,383 square kilometres, is the largest region in Ghana in terms of land area. It shares boundaries with the Upper East and the Upper West Regions to the north, the Brong Ahafo and the Volta Regions to the south, and two neighbouring countries, the Republic of Togo to the east, and La Cote d' Ivoire to the west. According to Ghana 2010 Population and Housing Census (PHC) the northern region has a total population of 2,479,461 persons with an active labour force of 15years or older being 41.3% of the total population (GSS, 2013). The census results also revealed that majority (73.7%) of the active labour in the region are employed in the agricultural sector. The climate of the region is relatively dry, with a single rainy season that begins in May and ends in October. The annual rainfall in the region varies between 750 mm and 1050 mm with a maximum temperatures occurring towards the end of the dry season (Ghana District repository, 2006; available on http://www.ghanadistricts.com/region/?r=6 retrieved on 1st February, 2014).

2.1 Method of Data Collection

Information about Farmers Based Organizations (FBOs) in the Region was obtained from the official website of Northern Regional Agricultural Development Units (available on http://mofafoodsecurity.wordpress.com/ as at February, 2014) which contained all FBOs in the all the Districts in the region. Contact details of all FBOs such as contact person, location, membership structure, registration status among others are all recorded in the document posted on the website. The records captured six hundred and twenty-one (621) FBOs spread over all the twenty six Districts in the Northern Region known to the Ministry of Food and Agriculture (MOFA). From this list only FBOs engaged in crop production in each of the twenty six (26) Districts were targeted for this study. Three (3) crop Based FBOs were randomly selected from each District making a total targeted FBOs of 78. However, 64 FBOs (representing 82%) of the initial targeted number were successful contacted through their contact persons and with the help of Agricultural Extension Agents in the various districts and communities. FBOs contact persons were asked to select five (5) leaders from their respective organizations, making a total sample size targeted to be 320, for them response to a prepared questionnaires to be sent them.

The Q methodology was used in collecting data for this paper. As observed by Barry and Proops, (1999), Q methodology involves a number of stages in gathering views and perception people hold about an issue. The stages consist of the following.

First, the researcher identifies the area of discourse and the relevant population (in this current study, farmers from organized farmer groups). Having done so, the second stage involves the collection of statements (opinions) relating to the discourse by posting opened ended questions to a selected few from the targeted population. The third stage is the selection of a limited number of representative statements from all responses to the open ended questions. This is follow by asking participants to rank or 'sort' the statements against a scale (usually strongly agree to strongly disagree). After gathered respondents' agreement ranks, statistical analysis of the 'sorts' is then carried out to enable interpretation of respondents' perception. Finally, these typical sorts are described and interpreted (Proops *et al*, 1999). This method was also used by Hall, (2010) in investigating farmer attitudes towards genetically modified crops in Scotland and Kenneth (2011) in assessment of Public Perception, Awareness and Knowledge on Genetically Engineered Food Crops and their Products in Trans-Nzoia County, Kenya. In employing the Q methodology to gathered relevant information to measure farmers' perception about GM crops, two phase process were employed. The first phase consisted of a short telephone interview with one leader from each of the 64 FBOs sampled for this study. During the telephone interview they were asked 'what do you know about Genetically Modified Crops'. They were allowed to express themselves and their responses to the question were captured in the form of statements. The statements gathered were sorted into 12 statements and grouped into three as 'those expressing their view about benefits of GM crops', 'those that were relating to their perceptions about possible risks associated with GM crops' and finally 'those statements which portrayed their scepticisms and speculations about GM crops'. The second phase which came one month after the first phase involved distributing of structured questionnaire designed to measure farmer agreement ranks of the 12 statements to all the 64 FBOs through their contact persons to be filled in by five leaders from each FBO. As such 320 filled questionnaires were expected back. However, two months after the questionnaires were distributed, 309 were returned and 305 were found to be properly filled and usable. As results, the study is based on 305 FBOs leaders as its sample size.

2.2 Data Analysis and Presentation

In measuring respondents' perception about GM crops, their agreement rank to the twelve (12) sorted statements depicting their view about GM crops were recorded based on five points Likert Scale as 1 = Strongly Disagreed, 2 = Disagreed, 3 = Undecided, 4 = Agreed and 5 = Strongly Agreed. This method of measuring perception was used by Zakaria, Abujaja and Adam, (2014) in measuring students' perception about agribusiness as an employment option after graduation. Hall, (2010) also used this kind of Likert Scale in investigating farmer attitudes towards genetically modified crops in Scotland. The mean agreement ranks for each of the 12 statements were analysed and t and F-distribution used to test for significant difference.

3.0 RESULTS AND DISCUSSION

3.1 Characteristics of FBOs

Since 2002 there had being an appreciable effort at forming and nurturing Farmer Based Organizations (FBOs) in the Northern Region. Ever since, Farmer Based Organizations have been playing and continue to play critical role in facilitating farmers' participation in agricultural research and development in Ghana. From the records of Northern Regional Agricultural Development Unit, at present there are six hundred and twenty-one (621) FBOs spread over all the twenty six Districts (available on http://mofafoodsecurity.wordpress.com/, accessed on 20th February, 2014), from which data and organizational contact were obtained for this paper.

Registrations of FBOs are usually done at the district level by MOFA and Department of Cooperative. However some FBOs are registered with the Registrar General's Department. About 25.5% of FBOs leader interviewed for the paper indicated that their FBOs are not registered, while the remaining 74.5% are registered with MOFA, Department of Cooperative or Registrar General's Department. Majority of the respondents (56.1%) have their FBOs registered with MOFA, while only 3.3% and 14.8% are members of FBOs registered with Registrar General's Department and Department of Cooperative respectively. However, most (82.6%) of the FBOs surveyed for this paper, have and operate bank accounts and hold regular meetings. As shown in Table 1a, about 21% of leaders of FBOs interviewed for this study were engaged in only cash crop enterprises such as soybeans, groundnut and

cashew, with 38% farming only food crops such as maize, yam, and rice. However, about 41% of them operate both food and cash crops. The 64 FBOs sampled for this study have a quite large membership ranging from 7 members to 450 members per FBO with a mean membership of 38.45 members per FBO as shown in Table 1b. In terms of gender disaggregation, the average male members per FBO were about 24persons compare with 15persons of that of female members. Indicating that the FBOs surveyed for this study were male dominated. This could be so because the focus of this study was FBOs who are into crop production and since crop production in Ghana is dominated by male, because of male controlled land tenure system in Ghana (see MOFA, 2012). Also the FBOs were fairly young with the average age of the organization being 8.24years with the oldest being 15years and the youngest just established 2 years ago.

3.2 Farmers Source Information

Extension information on improve varieties of crops and other agronomic practices is critical in improving crop productivity among peasant farmers and achieving the national food production targets require for the improvement in food security situation. Members of Farmers Based Organizations are expected to have better access to agricultural information because they operate in a group which facilitate collective demand and access to service delivery(see ; Salifu, Francesconi, and Kolavalli, 2010; AgSSIP 2007 and Onumah, Davis, and. Proctor 2007). More than half (56.7%) of the 305 members of FBOs interviewed, indicated that their main source of agricultural information on crops are Agricultural Extension Agents (AEAs) form Ministry of Food and Agriculture, while 23.6% and 19,7% sourced their information mainly from their fellow farmers and AEAs from Non-Governmental Organizations respectively. However, notwithstanding government efforts to promote farmers access to improved and certified seed for increase crop productivity, only 23% of the respondents planted their field during the last season with certified seeds from seed growers. The results further revealed that close to half (47.5%) of the respondents for this study; who are leaders of FBOs and for that matter opinion leaders and role models in their communities, still plant their fields with their own seeds stored from previous harvest and the remaining 29.5% indicating that they planted their fields with seed bought from the open market without knowing whether the seeds are certified or not.

Farmers were also found not to be consistency in the varieties of crop they being growing over the years. Majority (68.5%) of the farmers interviewed, as shown in the Table2, indicated that they have changed the variety of crop they been growing over the last five growing seasons. They contended that they have dropped some varieties of crops they were growing for better ones in terms of high yielding and disease resistance. This is understandable because more than half (56.7%) and 23.6% of the 305 leaders of FBOs surveyed ranked poor yield and disease or pest susceptibility respectively as the most severe problems associated with their current crop variety.

3.3 Farmers Knowledge and Source of Information on GM Crops

Being an emerging technology, made prominent within the last decade or so but however, received one of the biggest publicity in recent times, more than half (54.8%) of the 305 FBOs leaders interviewed have either heard of or read about GM Crop. Most (61.7%) of them indicated that they first got their information about GM crop from the mass media, mainly radio and television and only 3.6% have their information from Agricultural Extension Agents (AEAs) from MOFA while the remaining 34.7% were first informed about GM crops by their fellow farmers.

The basic knowledge about GM crop by the 167 respondents, who said they have ever heard of it, was found to be varied. Responses gathered from the respondents who are aware of GM crop, to the question ‘what do you know about GM Crop’ were classified into three categories to aid analysis. The three categories are ‘GM Crop are Unnatural Crops’; ‘GM Crops are high yielding crops’ and ‘GM Crops are variety of crops which can overcome crop production problems’. Out of the 57 respondents who knows of GM Crops as ‘unnatural’ and artificially produced from ‘Whiteman witchcraft’ (as they put it), 52 of them had their information from the mass media as illustrated in the figure 1. Whereas only 11 respondents out of the 43 respondents who understood GM crops as variety of crops which can overcome crop production problems such as susceptibility to diseases, pest and drought among others, heard of GM crops from the mass media too, the remaining 32 respondents either got their information about GM crops from

Agricultural Extension Agents (AEAs) or their fellow farmers. Also 40 respondents of the 67 respondents who understood GM crops to be high yielding crops got their information from the mass media and only 1 person and 26 respondents had their information from AEAs and their fellow farmers respectively. A similar finding was established by Kenneth (2011), which established that the mass media is the main source of information on GM crops and food to Kenya farmers and consumers alike.

It is clear from the findings from this study, that the mass media, particularly, radio and television, is the main source of information about GM crops to FBOs leaders interviewed for this study. This could be so because of the intense discussions, debates, campaigning for or against products of Genetically Modified Organisms (GMO) currently going on in many Ghanaian media. Therefore any communication strategy designed to promote and educate farmers on the benefits of application of agro biotechnology to accelerate agricultural production, should effectively engage the mass media for such communication.

3.4 Description of Farmers Perception towards GM Crop

Respondents of this study being leaders of their respective FBOs wield some level of influence on their fellow farmers and as such their perceptions towards Genetically Modified Crops will have consequential effect on the prospects of uptake of this technology by member farmers in their various Farmer Based Organizations. Using Q Methodology in gathering statements eliciting farmers' view and perceptions towards GM Crops, 12 statements were formulated from respondents' responses to open ended questions by one leader each from the 64 FBOs surveyed for this study.

Out of the 305 leaders of FBOs interviewed, 167 respondents indicated that they have ever heard or read about GM technology and as such have some information about Genetically Modified Organisms (GMOs) and GM Crops. They were further required to indicate their level of agreement regarding the 12 statements sorted from their response on 'what they think of GM crops' which formed the basis for measuring their perception towards GM crops using five points Likert Scale (1 – 5). The five points Likert Scale set up were: Strongly Disagree (with a weight of 1); Disagreed (with a weight of 2); Undecided (with a weight of 3); Agree (with a weight of 4) and Strongly Agreed (with a weight of 5). Table 3 presents statistical distribution of the mean score of respondents' agreement level on the statements. The statements were further sorted into perceptions regarding 'Possible benefits of cultivating GM Crops, perceptions regarding 'possible risks associated with the cultivation of GM Crops and perceptions associated with 'Farmers Scepticisms about GM Crops Cultivation'.

As shown in the Table 3, respondents alluded to certain prospective benefits of GM Crops cultivation as improvement in food security, breeding of improved variety of crops and reduce cost of production. The 167 farmers interviewed who indicated their awareness of GM crops, generally were in agreement that the possible introduction of commercial cultivation of GM Crops in Ghana will improve the food security situation. As shown in Table 3, about 28.1% and 27.5% respectively agreed and strongly agreed that GM Crops will lead to improvement in the country's food security situation. Also with a mean agreement rank of 3.70 (SD = 1.04; t = 45.30; df = 166; p = 0) indicates that respondents interviewed perceived that, commercial cultivation of GM Crops in Ghana will help improve the food security situation. Similar perception was observed on the view that GM Technology will lead to breeding of improved variety of crops such as high yielding disease and pest resistance and drought tolerance varieties. With average agreement rank of 4.04 (SD = 0.87;t = 59.65; df = 66; P = 0) farmers were of the perception that commercial cultivation of GM Crops will improve their access to high yielding disease and pest resistance, and drought tolerance varieties of crop. About 42.5% and 32.5% of the 167 respondents interviewed agreed and strongly agreed respectively, that GMO technology will help breed improved variety of crops to enable them increase their farm productivity.

However, respondents were undecided regarding the view that GM Crops cultivation will reduce their cost of production. About 43.1% were undecided whether the cultivation of GM Crops will reduce their cost of production, while only 11.4% and 15.6% respectively agreed and strongly agreed to the statement that 'GM Crop cultivation will reduce my cost of production'. With a mean agreement rank of 3.04 (SD = 1.14; t = 33.69; df = 166; p = 0), indicating that, respondents generally

were undecided regarding their agreement on the prospects of GM Crops cultivation reducing cost of crop production in Ghana.

Farmers concerns about possible risks associated with cultivation of GM crops were environmental risks, health risks, and market risks, as well as potential failures of government policies designed to safeguard the interest of consumers and producers. Respondents were generally in agreement with the potential market failures by consumers rejecting GM food because of the negative publicity it had received in many Ghanaian media, environmental risks as results of possible gene flow and emergency of resistance pest and the possible negative impact on ecological balance and biodiversity.

As shown in the Table 3, with mean agreement rank of 3.67 (SD = 1.53; t = 30.57; df = 166; p = 0), 3.86 (SD = 1.14; t = 43.07; df = 166; p =0) and 4.01 (SD = 1.12; t = 45.52; df = 166; p = 0), farmers interviewed generally agreed with the statements that, 'there is high risk of environmental negative consequence with the cultivation of GM Crops', 'Government Policies cannot be trusted to guard against potential risks of GMO' and 'Ghanaian consumers are more likely to reject GM food' respectively. As shown in the Table, about 12% and 48.5% respectively agreed and strongly agreed that the cultivation of GM Crops have a high potential negative impact on the environment, while only 15% strongly disagreed with the possible negative impact on the environment. Indicating that majority (60%) were of the opinion that cultivating of GM crops might pose potential environmental consequences. Earlier studies such as Smale and De Groote, (2003) have often raised possible environmental risks such as gene flow, evolution of resistance in the targeted pest populations, impacts on nontarget organisms. However, other studies have highlighted numerous exhilarating benefits which result from plant modifications on the environment, consumer and economic improvements (Steinbreecher 1996, Dunwell 2002, Laura *et al.* 2008).

Likewise, 26.3% and 38.9% agreed and strongly agreed respectively, with the perception of mistrust of government policies in safeguarding against the potential fall outs of GM crop cultivation inspite of the passage of Ghana Biosafety Act (Act 831) in 2011. The Act which is to ensure an adequate level of protection in the field of safe development transfer, handling and use of genetically modified organisms resulting from biotechnology that may have an adverse effect on health and the environment, appeared not to win respondents trust yet regarding adverse effect of GM Crop cultivation. Government might have to do more by way of education to win the trust and confidence of farmers in adopting the cultivation of genetically modified crops.

Respondents also harboured reservations of Ghanaian consumers rejecting GM food and its effects on their farming enterprises. Close to half (47.3%) of the 167 respondents strongly agreed that, there is a possibility of market failure for GM food among Ghanaian consumers and additional 21.6% also agreed to the possible market failure for GM food. Implying that, majority (68.9%) of FBOs leaders interviewed fear that they might not get market for GM products if they should cultivate GM crops. This perception could perhaps be fuelled by the negative propaganda campaign embarked on by some NGOs and civil society organizations campaigning against application of GMO technology in commercial agriculture production and the passage of the Plant Breeders' Protection Bill currently being considered by the parliament Ghanaian.

Also notwithstanding the assurance in the Biosafety Act, respondents generally were undecided with regards to their agreement on potential health risk pose by the production and consumption of GMO products. Respondents average score on their agreement level on the statement that 'GM Crop cultivation and consumption poses a potential high health risks' was 3.33 (SD = 1.0, t = 42.27, df = 166 and p = 0) indicating that respondents have not yet made up their mind regarding the perceived potential health risks of GMOs. As shown in Table 3, about 39.5% of the 167 respondents interviewed were undecided regarding their agreement on 'perceived potential health risks of GMO' while only 1.8% and 15% indicated strong disagreement and strong agreement respectively. With regard to the capacity of farmers to deal with potential fall outs that might come with the cultivation of GM crops, respondents generally were undecided in the assessment of their own capacity to deal with potential risks of cultivating GM Crops. Respondents average score on the agreement level on the statement that 'I lack the capacity to deal with potential risks associated with the cultivation of GM Crops' was 3.38 (SD =

1.22, t = 35.14, df = 166 and p = 0) indicating their undecidedness regarding their own ability to deal with the perceived risks associated with the cultivation of GM crops.

Other statements relating to perception of respondents which can be argued as their scepticisms concerning cultivation of GM crops were that 'GM Crops is incompatibility with my farming system', 'GMO will destroy endogenous crop varieties' ' GMO technology is sacrilegious' and 'GM crop cultivation will make Ghanaian farmers dependent on foreign companies'. While respondents generally agreed that GM crop cultivation might not be compatible with their current farming system, they were undecided with regarding the scepticism that GM crop cultivation might destroy endogenous crop varieties and make Ghanaian farmers dependence on foreign seed companies and that the cultivation of GM crop is sacrilegious in religious point of view. As shown in the Table 3, more than half (55.1%) of 167 respondents strongly agreed that GM crops might not be compatible with their farming system and that they might not be able to meet the agronomic and economic demands of the GMO technology. Also 43.1% were undecided with the perception that cultivation of GM crop is sacrilege while only 15.6% and 9% strongly agreed and strongly disagreed that GMO is sacrilegious in religious point of view inspite of the move by Faith Based Organization in Ghana to discourage the production and consumption of genetically engineered crops (see http://foodsovereigntyghana.org/ accessed on 20th June, 2014).

3.5 Influence of Farmers' Knowledge on perception towards GM Crops

Respondents' basic knowledge regarding GMO Technology and GM crop in particular were assessed based on their response to the question 'what do you know about GMO and GM Crop'. Respondents with some accurate knowledge about GM Crops were classified as 'Yes' having basic knowledge about GM crops and 'No' otherwise. Out of the 167 respondents who were aware of GM crops, 107 (representing 64.1%) viewed GMO as a means of breeding high yielding disease and pest resistance, and drought tolerance varieties of crops, capable of solving crop production problems and as such were classified as 'Yes' to having basic knowledge about GMO. With the remaining 60 respondents (representing 35.9%) whose knowledge of GMO and GM crops were to the effect that GM crops are artificial crops created by scientists which are different from natural crops they known or that GM crops are unnatural crops produce from 'Whiteman 'witchcraft' as they put it. Those with such knowledge about GMO and GM crops were classified as 'No' to possessing basic accurate knowledge of GMO or GM crops.

Farmers basic knowledge about GMO and GM crops are expected to have significant influence on their perception regarding GM crops and their subsequence adoption decision. As such F statistics were used to test for significant difference between mean agreement ranks of respondents with accurate basic knowledge about GMO and GM crops and those without such basic knowledge. Results of the statistical distribution are presented in Table 4. As shown in the Table, mean agreement ranks of respondents regarding the statements that 'GMO technology will improve their access to improved variety of crops', 'I lack the capacity to deal with potential fall outs of GM crops cultivation' and 'GM crop cultivation will pose high environmental risks'. As well as 'mistrust of the ability of government policies being able to safeguard the interest of GM crop producers and consumers, 'GM crops cultivation might not be compatible with my farming system' and 'GM crops cultivation will destroy endogenous crop varieties' were found to be significantly different at both 5% and 1% levels of significant, between respondents with accurate basic knowledge about GMO and those without accurate basic knowledge.

Whereas respondents with basic knowledge of GM crop scoring an average agreement rank of 3.12 (SD = 0.92) on their agreement with regard to the statement that 'I lack the capacity to deal with potential fall outs of GM crops cultivation, indicating that they were generally undecided regarding the statement, those without basic knowledge have a mean agreement score of 3.85 (SD = 0.90) on the statement, indicating that they were more inclined to agreeing that they lack the capacity to deal with potential fall outs of GM crops cultivation. Also, while respondents with accurate basic knowledge on GMO were generally undecided (with a mean agreement rank of 3.36 and SD = 1.04) regarding the likely environmental risks associated with GM crop cultivation, those without basic knowledge agreed to the high possibility of environmental risks associated with GM crop cultivation with

average agreement rank of 4.12 (SD = 1.07). Also both respondents with basic knowledge of GMO and those without such knowledge with an average agreement ranks of 3.74 and 4.07 respectively in absolute term were in agreement with the statement that 'I do not trust government policies on GMO safeguarding the interest of farmers and consumers'. However those without basic knowledge were more likely to be strong in their mistrust of government policies being able to safeguard potential fall outs of GM crops cultivation.

Similar difference ranks of respondents' agreement level on the statement that 'GM crop cultivation is incompatible with my farming system' were observed between respondents with basic knowledge on GMO and those without such accurate knowledge. While respondents mean agreement rank for those with basic knowledge on GMO was 3.40 (SD = 0.93) indicating general undecidedness among them regarding the perceived fears of incompatibility of GM crop cultivation with their current farming system, those respondents without basic knowledge about GMO were strong in their agreement that GM crops cultivation might not be compatible with their farming system with average agreement rank of 4.90 (SD = 0.93; df = 165; 149; p = 0.00). Likewise, whereas respondents with basic knowledge about GMO were generally undecided with a mean agreement rank of 3.12 (SD = 0.92) regarding the statement 'GM crop cultivation will destroyed endogenous crop varieties', those without accurate basic knowledge were more incline to agreeing with the statement scoring an average agreement rank of 3.85 (SD = 0.90).

Also the average agreement ranks of respondents with accurate basic knowledge about GMO and those respondents without such knowledge, were found to be significantly different at only 5% level of significant regarding the statement 'GM crop cultivation will help reduce my cost of production', 'cultivation of GM crops is a sacrilege' and 'GM crop cultivation will make Ghanaian farmers dependent on foreign seed companies'. Contrarily to apriori expectation, while respondents with accurate basic knowledge about GM crop were found more incline to be undecided with an average agreement rank of 2.80 (SD = 0.94) on the statement that 'GM crop cultivation will reduce my cost of production', those without accurate knowledge of GM crop were more likely to agreeing with the possibility of reducing their cost of production by adopting GM crop cultivation, scoring an average agreement rank of 3.45 (SD = 0.96). This unexpected finding could perhaps be as a result of the high scientific nature of GMOs technology, farmers with some level of knowledge on it are not able to fully understand the intrinsic details of the application of the technology in agriculture. However, with regard to the statement that 'GM crop cultivation is a sacrilegious', respondents with basic knowledge about GM crops were generally yet to make up their minds regarding their agreement with the statement, scoring an average agreement rank of 2.78 (SD = 0.94) as compare with the score of agreement of 3.47 for those without basic knowledge about GM crops indicating that they were more likely to agreeing with the statement.

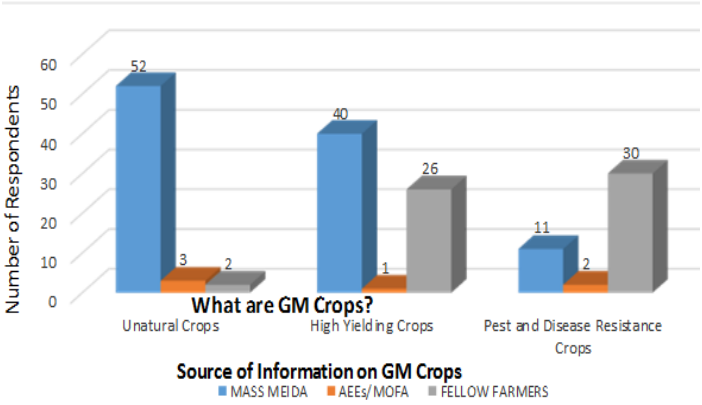
Similar differences in average agreement ranks were observed between respondents with basic knowledge about GM crops and those without such knowledge regarding the statement that 'GM crop cultivation will make Ghanaian farmers dependence on foreign companies'. Respondents with basic knowledge about GM crops as shown Table 4, with average agreement rank of 2.60 (SD = 0.90) compare with the average agreement rank of 3.65 for those without basic knowledge about GM crops. Indicating that, whilst respondents with basic knowledge about GM crops were generally more likely to be neutral in their agreement about the argument that GM crops cultivation might make Ghanaian farmers dependence on foreign seed companies, those without basic knowledge about GM crop were generally more incline to accepting the augment.

Finally, as shown in the Table 4, no significant difference was found in the mean agreement ranks of respondents with basic knowledge about GM crops and those without basic knowledge regarding the statements that 'GM crops will help improve on the food security situation in the country', 'GM crop products might be rejected by consumers' and 'possible health risks associated with the cultivation and consumption of GM food'. It was found curious, that regardless of level of knowledge of respondent, they all held the view that GM crop cultivation will help improve on the food security situation of the country, whilst at the same time, they were in agreement with the fear that Ghanaian consumers might reject GM food leading to market failure for the products of GM crops. This could be attributed to the massive propaganda in Ghanaian media cycle bringing to the public domain misinformation about the

possible health risks associated with consumption of GMO products by campaigners against GM crops.

FIGURE

Figure 1: Source of Information and Farmers Basic Knowledge about GM Crops



Analysis of Field survey Data, 2013

TABLES

Table 1a: Distribution of FBOs Characteristics

Characteristics	Variables	Number	Percent (%)
Registration Status	Registrar General's Department	10	3.3
	Ministry of Food and Agric. (MOFA)	171	56.1
	Department of Cooperatives (DOC)	45	14.8
	Not Registered	79	25.9
	Total	**305**	**100.0**
Does the Group have Bank Accounts	No	53	17.4
	Yes	252	82.6
	Total	**305**	**100.0**
FBO Collective Enterprise	Food Crop Production	116	38.0
	Cash Crop Production	64	21.0
	Both	125	41.0
	Total	**305**	**100.0**

Source: Field Survey, 2013 N=305

Table 1b: Description of FBOs Membership Structure

FBO Membership Structure	Minimum	Maximum	Mean	Std. Deviation
Total Membership	7.00	450.00	38.45	64.49
Number of Male in the FBO	0.00	360.00	23.83	49.69
Number of Female in the FBO	0.00	200.00	14.96	27.65
How old is the FBO	2.00	15.00	8.24	3.69

Source: Field Survey, 2013 N = 305

Table 3: Distribution of Farmers Personal Attributes

Farmers Personal Attributes	Variables	Number	Percent (%)
Source of Information Type of seed	AEAs/MOFA	173	56.7
	Fellow Farmer	72	23.6
	AEAs/NGOs	60	19.7
	Total	**305**	**100.0**
	Certified seed	70	23.0
	Own seed	145	47.5
	Seed bought from market	90	29.5
	Total	**305**	**100.0**
Change of Variety of crop	Yes	209	68.5
	No	96	31.5
	Total	**305**	**100.0**
Problem with crop variety	Poor yield	173	56.7
	Disease/pest susceptibility	72	23.6
	Low germination ratio	60	19.7
	Total	**305**	**100.0**

Source: Field Survey, 2013 N = 305

Table 3: Distribution of Farmers' perception and Mean Agreement Ranks

STATEMENTS	Extent of respondents' agreement or otherwise (% of the total)[a]					Descriptive statistics of mean scores				
	SD	D	U	A	SA	Mean	SD	t	df	p
Benefits										
Improvement in food security	2 1.2%)	20 (12)	52 (31.1)	47 (28.1)	46 (27.5)	3.70	1.04	45.30	166	0.00
Breeding of improved variety of crops	1 (0.6%)	8 (4.8%)	32 (19.2%)	71 (42.5%)	55 (32.9%)	4.04	0.87	59.65	166	0.00
Reduce my cost of production	15 (9%)	35 (21)%	72 (43.1%)	19 (11.4%)	26 (15.6%)	3.04	1.14	33.69	166	0.00
Possible Risks										
Environmental risks	25 (15%)	20 (12%)	21 (12.6%)	20 (12.0%)	81 (48.5%)	3.67	1.53	30.57	166	0.00
Mistrust of Government Policies on GMO	2 (1.2%)	27 (16.2%)	29 (17.4%)	44 (26.3%)	65 (38.9%)	3.86	1.14	43.07	166	0.00
health risk to consumers and producers	3 (1.8%)	31 (18.6%)	66 (39.5%)	42 (25.1%)	25 (15.0%)	3.33	1.00	42.27	166	0.00
Market Failure for GM food	2 (1.2%)	21 (12.6%)	29 (17.4%)	36 (21.6%)	79 (47.3)	4.01	1.12	45.52	166	0.00
I lack the capacity	13 (7.8%)	30 (18%)	34 (20.4%)	57 (34.1%)	33 (19.8%)	3.38	1.22	35.14	166	0.00
Scepticisms										
Incompatibility with farming system	2 (1.2%)	16 (9.6%)	37 (22.2%)	20 (12.0%)	92 (55.1%)	4.10	1.12	46.63	166	0.00
Destruction of endogenous crop varieties	14 (8.4%)	30 (18%)	34 (20.4%)	56 (33.5%)	33 (19.8%)	3.38	1.22	35.14	166	0.00
GMO is a sacrilege	15 (9%)	35 (21%)	72 (43.1%)	19 (11.4%)	26 (15.6%)	3.04	1.15	33.69	166	0.00
Dependency on foreign companies	15 (9%)	35 (21%)	72 (43.1%	19 (11.4%)	26 (15.6%)	3.04	1.15	33.69	166	0.00

Source: Field Survey, 2014 N = 167

Likert Scale: 5 = Strongly Agree (SA); 4 = Agree (A); 3 = Undecided (U); 2 = Disagree (D); 1 = Strongly Disagree (SD): SD = Standard Deviation. Figures in brackets indicate percentage of total number of respondents

Table 4: Distribution of perception and knowledge score on GM Crops

STATEMENTS	Basic Knowledge about GM Crops				F	df	Sign
	Yes (n = 107)		No (n = 60)				
	Mean	SD	Mean	SD			
Improvement in food security	3.80	0.93	3.68	0.93	1.41	165; 140	0.24
Improving access to improved variety of crops	4.15	0.92	3.83	0.92	5.99**	165; 109	0.00
I lack the capacity	3.12	0.90	3.85	0.90	19.29**	165; 158	0.00
Market Failure for GM food	3.95	1.07	4.12	1.07	0.25	165; 129	0.62
Reduce my cost of production	2.80	0.96	3.45	0.96	1.26*	165; 143	0.04
Environmental risks	3.36	1.04	4.22	1.04	51.67**	165; 163	0.00
Mistrust of Government Policies on GMO	3.74	0.90	4.07	0.90	11.96**	165; 154	0.00
health risk to consumers	3.20	0.90	3.57	0.90	0.95	165; 138	0.33
Incompatibility with farming system	3.40	0.93	4.90	0.93	10.39**	165; 149	0.00
Destruction of endogenous crop varieties	3.12	0.90	3.85	0.90	19.29**	165; 158	0.00
GMO is a sacrilege	2.78	0.94	3.47	0.96	1.26*	165; 143	0.03
Dependency on foreign companies	2.60	0.90	3.65	0.96	1.26*	165; 143	0.03

Source: Field Survey, 2014; * significant at 0.05 significant level and **significant at 0.01 significant level

Likert Scale: 5 = Strongly Agree; 4 = Agree; 3 = Undecided; 2 = Disagree; 1 = Strongly Disagree: SD = Standard Deviati

4. Conclusion And Recommendations

Majority of Leaders of Farmers Based Organizations (FBOs) in Northern Region of Ghana have either heard of or read about GMOs Technology and GM crops, with close to two-third (64%) of them having appreciable knowledge about the technology. Also leadership of FBOs in the region are of the opinion that commercial application of agro biotechnology will help boost the country's food security situation through breeding of improved variety of crops. They were however, undecided regarding the view that GM Crops cultivation will reduce their cost of production. Farmers concerns about possible risks associated with the cultivation of GM crops were environmental risks, health risks, and market risks, as well as potential failures of government policies designed to safeguard the interest of consumers and producers. While respondents generally agreed that GM crop cultivation might not be compatible with their current farming system, they were undecided with regard to the scepticism that GM crop cultivation might destroy endogenous crop varieties and make Ghanaian farmers dependence on foreign seed companies and that the cultivation of GM crop is sacrilegious in religious point of view. Farmers' knowledge about GM crops was found significant in influencing their perception towards the application of GMOs Technology in commercial agricultural production.

It is therefore recommended that government through Ministry of Food and Agriculture need to intensify farmer education on government agro biotechnology policy and the expected benefits to farmers. Also National Biosafety Authority and other relevant institutions such as biotechnology research institutions and extension organizations should actively engage Farmer Based Organizations at the grassroots in planning and implementing the country's agro biotechnology agenda. Finally information dissemination mechanism on GM crops should be streamline to avoid misinformation and to help boost farmers' confidence on GM crops and their prospective adoption.

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REFERENCES

[1] AgSSIP (Agricultural Services Sub-sector Investment Project). 2007. Implementation completion and results report. A World Bank document presented to the Republic of Ghana. Washington, D.C.: WorldBank.

[2] Aref F 2011. Farmers' participation in agricultural development: The case of Fars province, Iran. Indian Journal of Science and Technology, 4(2): 155- 158.

[3] Barry, J. & Proops, J., 1999. Seeking sustainability discourses with Q methodology. Ecological Economics, 28; 337-345

[4] Brookes G., Barfoot, P., 2011. GM crops: global socio-economic and environmental impacts 1996-2009. PG Economics Ltd, Dorchester, UK.

[5] Charles Hanrahan 2010, "Agricultural Biotechnology: The U.S. – EU Dispute," CRS Report for Congress RS21556, 8 April, http://digitalcommons.unl.edu/crsdocs/69/ (28 April, 2014)

[6] Clare Hall, 2010. Identifying farmer attitudes towards genetically modified (GM) crops in Scotland. LAND ECONOMY WORKING PAPER SERIES Number 6. Land Economy Research Group SAC Edinburgh EH9 3JG.

[7] David Baulcombe , Jim Dunwell, Jonathan Jones, John Pickett, Pere Puigdomenech, 2014. 'GM Science Update; A report to the Council for Science and Technology'

[8] Dunwell, J.M. 2002. Future prospects for transgenic crops. Phytochem. Rev. 1 pp. 1–12.

[9] Elmasoeur Ashitey 2013. Ghana Agricultural Biotechnology Annual Report. Global Agriculture Information Network. USDA Foreign Agricultural Services

[10] Ghana District Repository 2006. Districts in Northern Region (Available on http://www.ghanadistricts.com/region/?r=6 retrieved on 20th April, 2014)

[11] GSS, 2013. Regional Analytical Reports; Northern Region. 2010 Population and Housing Census, Ghana Statistical Service, GSS, June, 2013 Accra.

[12] Iqbal M 2007. Concept and implementation of participation and empowerment: Reflection from coffee IPM-SECP. Makara, Sosial Humaniora, 11 (2): 58- 70.

[13] ISAAA, 2014. Global Status of Commercialized Biotech/GM Crops: 2013. ISAAA Brief 46-2013: Executive Summary. Available on http://www.isaaa.org/inbrief/default.asp (Accessed on 24th June, 2014)

[14] James, C. 2012. Preview: Global Status of Commercialized Biotech/GM Crops: 2012. ISAAA Briefs No. 44. ISAAA: Ithaca, NY.

[15] James, C., 2008. Global status of commercialized biotech/GM crops 2008. ISAAA Brief no. 39, ISAAA, Ithaca, NY.

[16] Jerome Legge and Robert Durant, 2010. "Public Opinion, Risk Assessment, and Biotechnology: Lessons from Attitudes toward Genetically Modified Foods in the European Union," Review of Policy Research 2, no.1 59-76.

[17] Kenneth Kinuthia Kagai, 2011. 'Assessment of Public Perception, Awareness and Knowledge on Genetically Engineered Food Crops and their Products in Trans-Nzoia County, Kenya', Journal of Developments in Sustainable Agriculture 6: 164-180 (2011)

[18] Laura M. Zahn, Pamela J. Hines, Elizabeth Pennisi, and John Travis 2008. Green genes. Science 320 (5875), 465.

[19] MoFA , 2012, 'Performance Of The Agricultural Sector In Ghana: 2006-2012. Gross Domestic Product (GDP) At 2006 Prices By Economic Activity: 2006-2012

[20] National Campaign Against UPOV/Plant Breeders' Bill, 2014. FAITH-BASED ORGANIZATIONS' POSITION ON THE PLANT BREEDERS' BILL AND GENETICALLY MODIFIED ORGANISMS IN ACCRA ON 19TH JUNE 2014 (Available on http://foodsovereigntyghana.org/ accessed on 20th June, 2014)

[21] Nxumalo K. K. S. and O. I. Oladele, 2013. Factors Affecting Farmers' Participation in Agricultural Programme in Zululand District, Kwazulu Natal Province, South Africa. Kamla-Raj 2013 J Soc Sci, 34(1): 83-88 (2013).

[22] Odhiambo, A. 2007. Annan rules out use of GMOs in the war on hunger in Africa. Business Daily (Kenya). http://www.gmwatch.org/archive2.asp?arcid=8110

[23] Onumah, G. E., J. R. Davis, U. Kleih, and F. J. Proctor. 2007. Empowering smallholder farmers in markets: Changing agricultural marketing systems and innovative responses by producer organizations. ESFIM Working Paper 2: IFAD, CTA, AGRICORD.

[24] Robert M_ Yawson, Wilhelmina Quaye, Irene Entsi Williams & Ivy Yaws on, (2008). A Stakeholder Approach to Investigating Public Perception and Attitudes towards Agricultural Biotechnology in Ghana. TAILORING BIOTECHNOLOGIES Vol. 4, Issue 1/1, fall-1OO8, pp: 55-70

[25] Salifu, A., Francesconi, G. N., and Kolavalli, S. 2010. "A review of collective action in rural Ghana". IFPRI Discussion Paper 998 International Food Policy Research Institute (IFPRI).

[26] Smale, M., De Groote H., 2003. Diagnostic research to enable adoption of transgenic crop varieties by smallholder farmers in Sub-Saharan Africa. African Journal of Biotechnology 2 (12), 586-595.

[27] Steinbreecher, R. A (1996). From green to gene revolution: The environmental risks of genetically engineered crops. The ecologist 26:273-282.

[28] Sylvie Bonny. 2003, "Why Are Europeans Opposed to GMOs? Factors Explaining Rejection in France and Europe," Electronic Journal of Biotechnology 6, no. 1 50-71.

[29] Zakaria H., Adam H. and Abujaja M.F. 2013. 'The Perception Of Agricultural Students And Self-Employment In Agribusiness: A Case Study of Students of University for Development Studies, ghana' .intentional journal of research in commerce and management. volume no. 4 (2013), issue no. 12(december) issn 0976-2183. EBSCO Publishing, U.S.A.