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Farmer Based Organizations in Northern Region of Ghana Intention to Adopt GM Crop: Empirical Application of Theory of Planned Behaviour

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ABSTRACT: Following the passage of Ghana Biosafety Act, 2011, (Act, 831) and the Plant Breeders' Protection Bills being currently under consideration stage in Parliament, there has been intense debate in many media platforms, on the safety and appropriateness of applying GMO technology in commercial agriculture. As such a lot of information is being chained out in the public domain with potential effect on farmers' prospective adoption decision. This paper presents findings of a study investigating factors predicting farmers' adoption intention from a survey of 305 members of Farmer Based Organizations in Northern Region of Ghana. A probit regression analysis was used in identifying factors which significantly predict farmers' adoption decision. The study found more than two –third of the farmers surveyed intending to adopt the cultivation of Genetically Modified crops. Results of the probit model estimates indicate that farmers' 'basic knowledge about Genetically Modified crops', 'crops income as a ratio of household annual income' and 'mistrust of government policy on GM crops' are significant in predicting farmers' adoption decision. It is recommended that Ministry of Food and Agriculture, agricultural biotechnology research institutions and other relevant organizations, should help provide farmer education on the benefits of applying Genetically Modified Organisms technology in agriculture.

KEYWORDS: GM Crops, GMO Technology, Biosafety Act, Adoption and Intention.

1 INTRODUCTION

In today's competitive and fast moving global arena, no country can afford to stand aloof from the happenings and advances in global knowledge and innovative development. In this era of globalization, facilitated through advances in Information and Communication Technology, the speed of knowledge generation and transmission have been quicken, propelling development in all sectors of human endeavour. Agricultural sector, which for a very long time remains the backbone of economies of many developing countries (FAO, 2013), had largely benefited from technology development driven mainly through application of scientific innovation in crop production, animal rearing and management of natural resources.

For over two decades now, global agricultural production had benefited from the breakthrough in crop breeding through the application of Genetic Engineering which allows breeders to adjust, modify or alter the genomes of target organisms for improved performance and much desired results (CSIS Global Food Security Report, 2010). Genetic Engineering Technology had enable breeders to overcome natural limitations and barriers which hitherto prevented them from transferring desire traits from one organism to the other. It has therefore unleash a huge potential for crop breeders to produce better performing varieties of crops capable of overcoming inherent limitations such as disease and pest susceptibility, low yielding among others (see Baulcombe, Dunwell, Jones, Pickett and Puigdomenech, 2014; Laura, Pamela, Elizabeth and John 2008 and Ferber1999).

Realizing the huge potential of Genetically Modified Organisms (GMOs) technology and Genetically Modified Crops (GMC) in particular, government of Ghana have for some time now been putting in place measures to enable the country's

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agricultural sector benefit from the technology. This saw the enactment of Biosafety Act (**Act** 831) in 2011 to provide legal framework to guide the generation and application of GMOs. The objective of the Act is to: *(a) '*ensure 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, and *(b)* establish a transparent and predictable process to review and make decisions on genetically modified organisms specified in paragraph *(a)* and related activities' (*Biosafety Act, 831, 2011; pp3).* Also Plant Breeders Protection Bill is currently being considered by Ghanaian parliament to provide legal bases for protecting intellectual property of plant breeders and research institutions applying GMOs technology in producing improved varieties of crops. This will create a favourable environment for the development and commercialization of biotechnology seeds and crops as observed by Ashitey, (2013).

With the passage of Biosafety law, Ministry of Environment, Science, Technology and Innovation had given indication that the country would adopt the Genetically Modified Organisms (GMOs) technology to improve agricultural production and income for farmers (GNA, 2013). As part of the move to adopt commercial production of GM crops, Savannah Agricultural Research Institution (SARI) of the Council for Scientific and Industrial Research (CSIR) is currently undertaking adoptive trials and research into genetically modified cowpea and cotton. SARI had established a biotechnology cowpea farm at Nyankpala in the Tolon District and a biotechnology cotton farm at Kpalkore in the Mion District (Ashitey, 2013 and GNA, 2013).

Inspite of this progress the country had made in ensuring the transformation of agriculture, which still remains the larger employer in the country (MOFA, 2012), through adoption of GMOs Technology, there is a strong and growing opposition mounted by campaigners against GMOs. Some Non-governmental and Civil Societies Organizations such Faith-Based Organizations, Action Aid Ghana, Centre for Indigenous Knowledge and Organizational Development and Peasant Farmers Association of Ghana coming under banner 'National Campaign Against UPOV/Plant Breeders' Bill' , are leading the campaign against the country's possible adoption of GMO technology in agricultural production, calling for the suspension and withdrawal of the Plant Breeders' Bills' (available on http://foodsovereigntyghana.org/ accessed on 20th June, 2014).

This stern opposition and misinformation being throw out there through the mass media will in no doubt influence farmers' perception and attitude towards GM crops and it will, as a matter of fact influence their decision to adopt GM crop cultivation when commercial application of GMO technology is finally introduce in the country. More so, since agriculture is largely on smallholder bases with family operated subsistence farms in the country (MOFA, 2010); farmers' voices and views are usually not fairly represented in decision making and formulation of national agricultural policies. It is as a results of this and many other reasons that the Ministry of Food and Agriculture (MOFA) through Agricultural Sub Sector Invest Programme (AgSSIP) with sponsorship of the World Bank had for about two decades now being encouraging and supporting farmers to come together to form Farmer Based Organizations (FBOs) throughout the country (see MOFA, 2012; Salifu, Francesconi, and Kolavalli, 2010 and AgSSIP 2007). As a result FBOs are now spread throughout the country, providing platform for farmers to collectively demand and access services such as extension, marketing information, input subsidies among others (Onumah, Davis, and. Proctor 2007).

However, very little is heard of them in this current debate on application of GMOs technology in commercial agriculture in Ghana. This current paper therefore discussed findings of a study which examined the perception and intention of leaders of FBOs in Northern Region of Ghana towards the adoption of GM crops when it is finally introduce in the country. It also investigated factors which predict farmers' adoption decision on GM crops adapting Ajzen (2006) Theory of Plan Behaviour in conceptualizing variables in the empirical probit regression model used.

1.1 THEORETICAL AND CONCEPTUAL FRAMEWORKS

A theoretical framework is a conceptual model of how one theorizes the relationships among the several factors that have been identified as important to the problem. Sinclair (2007) explained that a theoretical framework can be thought of as a map or travel plan. When planning a journey in unfamiliar country, people seek as much knowledge as possible about the best way to travel, using previous experience and the accounts of others who have been on similar trips. This paper relied on relevant theory underpinning individual adoption decision and behaviour as a framework in identifying factors influencing farmers' decision regarding the adoption of GM crops. These theories included, Roger adoption and diffusion process ((see for example Armitage and Christian 2003; Venkatesh, Morris, Davis and Davis 2003; Rogers, 1962; Rogers and Shoemaker, 1971), 'Theory of Reason Action' (TRA) proposed by Fishbein and Azjen (1975), Ajzen (1991) 'Theory of Planned Behaviour' (TPB), which was further modified in Ajzen (2006) and the Technology Acceptance Model (TAM). It also relied on relevant literature on empirical studies regarding application of genetic engineering techniques and the adoption of GM crops in selecting and testing variables which can possible predict farmers' adoption decision on GM crops (see Ashitey, 2013; Kenneth, 2011; Hall, 2010; Laura*, et al*, 2008; FAO, 2009 and Koivisto-Hursti and Magnusson, 2003)

1.2 CONCEPTUAL FRAMEWORK

This paper adapted Ajzen, (2006) Theory of Planned Behaviour in conceptualizing predictors of farmers' intention to adopt GM crop cultivation. As shown in the Figure1, farmers' attitude towards GM crops reflecting their perception about the possible outcome of adopting the technology (which is informed by the information and knowledge they have about the GMOs) is conceptualized as exerting influence on farmers' prospective adoption decision. Also individual farmers' perceptions and personal attributes influence their decision to adopt GM crops or otherwise, are subject to societal view about the technology. With regard to perceived behavioural control which is visualized as the beliefs regarding absence or presence of factors that might facilitate or impede the adoption of the technology such as perceptions about benefits or risks associated with GM crops, source of information and knowledge about GMOs and socioeconomic factors of farmers such as age, education and experience in crop production, compatibility, complexity or otherwise and cost involved in adopting the technology, were all examined as having influence on farmers' adoption decision. The visual representation of this is shown in the Figure 1 below.

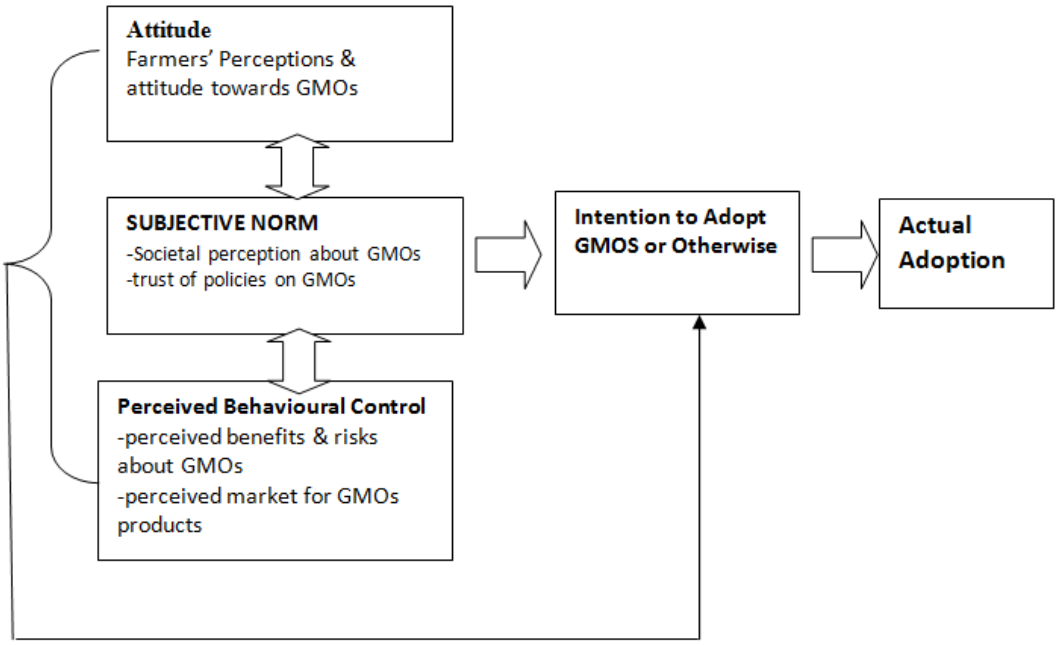

Figure 1: Conceptual Framework

Source: Adapted from Ajzen, 1991

2 MATERIALS AND METHODS

Data for this paper was obtained from a survey of Farmer Based Organizations (FBOs) in the Northern Region of Ghana. Information about Farmers Based Organizations (FBOs) in the Region was obtained from official website of Northern Regional Agricultural Development Unit (available on http://mofafoodsecurity.wordpress.com/ as at February, 2014) which contained all FBOs in all the Districts in the region. From the records of Northern Regional Agricultural Unit, there were 621 registered FBOs spread in the twenty six (26) Districts in the region. A multi-stage sampling method was employed in sampling respondents for this study. The first stage involved a random sampling of three (3) FBOs from each District making a total of 78 FBOs targeted. 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. The second stage involved the sampling of five (5) members from each of the 64 sampled FBOs making a total sample size of 320. However, two months after the questionnaires were distributed, 309 were returned and 305 were found to be properly filled and usable. As a result, the study is based on a sample size of 305 farmers from FBOs in Northern region of Ghana.

2.1 DATA ANALYSIS AND PRESENTATION

In measuring respondents' perception about GM crops, their agreement rank to twelve (12) sorted statements, collected through the application of Q methodology, depicting respondents' 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 F-distribution used to test for significant difference in the perception of farmers intending adopt GM crops and those who do not.

In predicting farmers' adoption intention, which is typically a dichotomous dependent variable (intend to adopt/otherwise), usually a Cumulative Distribution Function (CDF) is used. This paper adopted a probit model – also known as normit model (see Gujarati, 2004) in determining factors predicting farmers' adoption decision about GM crops. In settling on a specification model, the study adopted a modified probit modelling idea from Sesabo, et al (2006) generally expressed as: $I_i = f(X_i \ldots\ldots X_n)$. Where I_i represents individual's adoption decision (i = 1: intend to adopters/ i = 0: otherwise) and $X_1 \ldots Xn$ represent factors predicting farmers adoption behaviour.

The empirical model adopted was informed by Ajzen (2006) Theory of planned behaviour which posits that three antecedents – attitude, supportive norm and perceived behaviour control is fundamental in determining factors influencing individual adoption behaviour. Farmers' attitude towards GM crops will be fundamentally determined by their age, sex, experience in crop cultivation, educational background, farm size, income and source of information. Likewise supportive or subjective norm captured in a farmer' perception about other farmers views on GM crops and perceived behavioural control such as perceived benefits of growing GM crops, government policies on GM crops, possible health and environmental risks are all antecedents to farmers' intention to adopt GM crops.

The specified empirical model used is stated as:

$$Ii = \beta_0 + \beta_1 GENDERi + \beta_2 AGE + \beta_3 HH + \beta_4 NEDU + \beta_5 RELi + \beta_6 FARMZ + \beta_7 RATOIN + \beta_8 EXPERI + \beta_9 SOURINF + \beta_{10} LOCAT + \beta_{11} BKNGM + \beta_{12} TGPGM + \beta_{13} SATISCV_i + \beta_{14} GMIMES_i + \beta_{15} GMHEAR_i + \beta_{16} GMENR + \beta_{17} GMMARF_i + \mu$$

Where Ii = Intention to adoption (i = 1 for Intention to adopter/ i = 0 for otherwise), β = coefficients of independent variables as GENDER = Sex of respondents (i=1 for male; i = 0 for female), AGE = Age of farmers in years, NEDUC = Number of years of formal schooling; RELIGION = religious background of farmers (i = 1 for traditional; i = 0 for otherwise); FARMZ = Farm size in hectare; RATIOIN = crop income as ratio of household income; EXPERI = Experience in crop production in years; SOURINF = source of information about GM crops (i = 1 for mass media; i = 0 for otherwise), LOCAT = location of farmer (i = 1 for urban, i = 0 for otherwise); BKGM = basic Knowledge about GM crops (i= 1for having basic knowledge; i = 0 for otherwise), TGPGM = mistrust of government policy on GM crops (i = 1 for yes; i = 0 for otherwise), SATISCV = satisfied with current variety of crop (i = 1 for yes; i = 0 for otherwise); GMIMFS = GM crop improving food security (i = 1 for yes; i = 0 for otherwise); GMHEAR = Cultivating of GM crops poses high health risks (i = 1 for yes; i = 0 for otherwise); GMENR = Cultivating of GM crops poses high environmental risks (i = 1 for yes; i = 0 for otherwise); GMMARF = GM food might be rejected by Ghanaian consumers (i = 1 for yes; i = 0 for otherwise) and μ = error term.

3 RESULTS AND DISCUSSION

3.1 FARMERS PERCEPTION TOWARDS GM CROP AND ADOPTION DECISION

As argued by Ajzen (2006), individual perception about the possible outcome of behaviour influences their decision to adopt or reject the said behaviour. As such, this study examined the extent to which farmers perception about GM crops influence their intention to adopt its cultivation. Analysis of the survey results about farmers' awareness of GMOs and GM crops revealed that, out of the 305 leaders of the 64 FBOs surveyed for this paper, 167 of them, representing about 55% have heard or read about GM crops. The 167 respondents, who indicated their awareness of GMOs and GM crops, were asked a direction question, 'do you intend to adopt the cultivation of GM crops?' Analysis of their responses to the question indicated that 61 farmers (representing 36.5%) responded in the affirmative, indicating their intention to adopt the cultivation of GM crops.

Average agreement ranks of statements set up to measure respondents' perception towards commercial cultivation of GM crops by respondents who indicated their intention to adopt the cultivation of GM crops was compare with those who do

not intend to adopt its cultivation with F-statistics used to test if there exist any significant difference between their mean agreement ranks at 5% and 1% levels of significant. Results of the analysis and the mean distribution are presented in the Table 1 below. As shown in the table, respondents with the intention to adopt the cultivation of GM crops perceptions towards the fear that they may lack the capacity to cope with the fall outs of GM crops cultivation, possible lack of market for GM food and mistrust of government policies on GM crops. As well as potential environmental risks associated with the cultivation of GM crops and the perception that GM crops cultivation will not be compatible with Ghanaian farmers farming system, were all found to be significantly different at both 1% and 5% levels of significant from the mean agreement ranks of those respondents who do not intend to engage in the cultivation of GM crops. This compare fairly well with Kenneth, (2011) which established that farmers perception of market for GM crop products, knowledge about government policy among others influence farmers adoption of GMOS technology.

Examination of mean agreement ranks of both respondents with intention to engage in the cultivation of GM crops and those who do not, on the statement that 'I lack the capacity to deal with the possible fall outs of GM crop cultivation' revealed a contrast views. Whilst respondents who intent to cultivating GM crops were generally undecided with a mean agreement rank of 2.89 (SD = 0.89), those who do not intend to cultivating GM crops were generally in agreement with the statement scoring an average agreement ranking of 4.25 (SD =1.12). likewise, respondents with intention of engaging in GM crop cultivation were found more likely to disagreeing that there may be possible market failure for GM crop products with average agreement ranking of 2.03 (SD =0.81), whereas those who do not intend to cultivating GM crops were strong in their agreement, with average agreement rank of 4.83 (SD =1.24) on the fear of market failure.

Similar revelations were made with regard to the perception of possible environmental risks and mistrust of government policies on GM crops. Whilst respondents with the intention to adopt the cultivation of GM crops were generally found more likely to agreeing with possible environmental risks and mistrust of government policies on GM crops with average agreement ranks of 4.41 (SD = 1.03) and 4.59 (SD = 0.78) respectively, those without intention of growing GM crops were yet to decide on that. This was found strange because it was expected that those respondents with intention to engage in GM crops cultivation might be sure in their minds about institutional and policy support to enable them succeed in the application of such high level scientific technology. More so after appropriate legislative frameworks (see Biosafety Act, 2011: Act 831, Biosafety LI 1887 , 2008 and impending Plant Breeders' Bill) and institutional frameworks such as the establishment of National Biosafety Authority (NBA) have been put in place to ensure safety in the application of GMOs technology in agriculture as well as protect the interest of producers and consumers. It can then be argued that the fear of failure of government policies in safeguarding the interest of farmers in the adoption of GM crops is pervasive and could be as a result of farmers' lack of knowledge about government Biosafety legislations and policy framework. Yet still some progressive and risks loving farmers are not deter in their intention to grow GM crops despite their misgiving on government policies.

Also respondents intending to grow GM crops and those who do not were found to differ significantly at only 5% level of significant with regard to their view on the possibility of GM crops cultivation leading to reduction in cost of production, possible health risks associated with production of GM crops, GMO being a sacrilege and adoption of GM crops making Ghanaian farmer dependence on foreign seed companies. This confirmed early studies by Laura*, et al*, (2008) and Harrison and House (2004) both found perceptions of risk to human health and the environment influencing farmers approval and subsequent adoption of GM crops. Respondents who intent to engage in the cultivation of GM crops were in agreement with the statement that 'GM crops cultivation will reduce their cost of production' scoring an agreement rank of 4.13 (SD = 1.03) compare with 2.36 (SD = 0.75) of those who do not intent engaging in growing GM crops. Indicating that respondents who do not intend adopting the cultivation of GM crops disagreed with the notion that GM crops cultivation might reduce their cost of production. It can therefore be adduced that economic motive such as possible reduction of cost of production and the possibility of finding market for GM crop products are the driving factors that influence farmers' intention to engage in the cultivation of GM crops whilst other factors such as possible environmental risks and mistrust of government policies on GM crops are not likely to swerve farmers decision concerning the cultivation of GM crops. Also farmers' perception about the likelihood incompatibility of GM crops cultivation with their existing farming system hold swerve on their intention to adopting the technology. As shown in Table 1, while respondents with the desire to adopting the cultivation of GM crops were found more likely to be undecided regarding their agreement on the statement that 'GM crops cultivation is incompatible with my farming system' with an average agreement rank of 3.42 (SD = 0.87), those who do not intent to engage in the cultivation of GM crops strongly agreed with a mean agreement rank of 4.88 (SD = 1.23).

However, both respondents with intention to adopt GM crop cultivation and those who do not, were found not to differ significantly in their perception regarding improvement in food security situation in the country through GM crops cultivation and the prospects of GMO technology leading to breeding of improved varieties of crops and enhancing farmers access to viable and improved varieties of crops to replace the existing poor yielding, disease and pest susceptible varieties. Both group of respondents (those with intention to adopt GM crop and those who do not intend to adopt) were found more likely to

agreeing with the statement that 'GM crops cultivation will help improve the food security situation in the country' with a mean agreement ranks of 4.01 (SD = 0.93) and 3.60 (SD = 0.98) respectively. Likewise both categories of respondents were in agreement with the perception that GMO technology will help breed improved varieties of crops with average agreement ranks of 4.33 (SD = 0.81) and 3.87 (0.85) respectively.

Table 1: Comparative Mean Distributions of Farmers Perception Scores

STATEMENTS	Do you Intend to Adopt GM Crops				F	df	Sign
	Yes (n = 61)		No (n = 106)				
	Mean	SD	Mean	SD			
Improvement in food security	4.01	0.93	3.60	0.98	1.01	(165;130)	0.32
Breeding of improved variety of crops	4.33	0.81	3.87	0.85	0.14	(165;130)	0.71
I lack the capacity	2.89	0.89	4.25	1.12	7.20**	(165;148)	0.00
Market Failure for GM food	2.03	0.81	4.83	1.24	87.46**	(165;162)	0.00
Reduce my cost of production	4.13	1.03	2.36	0.75	3.45*	(165;162)	0.04
Poses high Environmental risks	4.41	0.84	3.24	1.67	81.57**	(165;163)	0.00
Mistrust of Government Policies on GMO	4.59	0.78	3.35	1.20	32.36**	(165;162)	0.00
Poses high health risk	4.05	1.01	2.92	0.73	5.45*	(165; 96)	0.02
Incompatibility with farming system	3.42	0.87	4.88	1.23	40.71**	(165;157)	0.00
Destruction of endogenous crop varieties	2.89	0.89	4.25	1.12	7.20**	(165;148)	0.00
GMO is a sacrilege	2.46	1.03	4.03	0.75	3.45*	(165; 96)	0.04
Dependency on foreign companies	2.46	1.03	4.03	0.75	3.45*	(165; 96)	0.04

Note: (**) indicate variable is significant at both 1% and 5% while (*) indicate the variable is significant at 5%.

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

Source: Analysis of Field Survey Data, 2013

3.2 RESULTS OF PROBIT ANALYSIS OF FACTORS PREDICTING FARMERS' ADOPTION DECISION

Probit model was estimated to predict farmers' intention to adopt GM crop. The estimated model coefficients, associated z-ratios, and marginal effects of the explanatory variables selected for predicting farmers adoption decision are presented in Table 4, with Table 2 and 3 describing the explanatory variables and mean distribution of the explanatory variables respectively. In preparing the variables to be used in the probit regression analysis, age in years, household size in numbers of persons, number of years of formal schooling completed, experience in crop production in years, farm size in the last season in hectares and crop income as a ratio of annual household income were all entered as ratio and continue data while the remaining variables were entered as dummy as shown Table 2.

Age was apriori expected to have negative relationship with intention to adopt GM crops since young farmers are more likely to be more enterprising and better informed. However number of years of formal schooling completed was to have positive relationship with farmers' intention to adopt since education had been proven to improve farmers' adoption of innovations (see Kenneth, 2011; Laura*, et al*, 2008 and Harrison and House 2004). Also farmers' knowledge about GM crops was expected to relate positively with intention to adopt because farmers with better knowledge and understanding about GM crop will be more intending to adopt its cultivation than otherwise as demonstrated by Kenneth, (2011).

Table 2: Descriptions of Variables in the probit model

Variable	Description	Apriori Expectation
GENDER	1 = Male; otherwise 0	+/-
AGE	Age in Year	-
HH	Household Size (in number persons)	+
NEDUC	Number of Years of formal schooling completed (in years)	+
RELIGION	Religious Background; (1 = traditional; otherwise 0)	+/-
FARMZ	Farm Size cultivation in the previous season (Ha)	+/-
RATIOIN	Crop income as a ratio of household income (GHS)	+
EXPERI	Experience in crop farming in Year	+
SOURINF	Source of information on GM Crops: (1 = Mass media; otherwise 0)	-
LOCAT	Residential Location of farmer (1＝Urban; 0＝Rural)	+/-
BKNGM	Having Basic Knowledge about GM crops (1 = yes; or otherwise; 0)	+
TGPGM	Mistrust of government policy on GMO (1 = yes; or otherwise; 0)	+
SATISCV	Satisfied with current crop variety (1 = Unsatisfied or otherwise 0)	-
GMIMFS	GM crops will improve food security situation (1 = yes or otherwise 0)	+
GMHEAR	GM crops poses high health risks (1 = yes or otherwise 0)	-
GMENR	GM crops poses high environmental risks (1 = yes or otherwise 0)	-
GMMARF	GM crop might be rejected by consumers (1 = yes or otherwise 0)	-

Source: Analysis of Field Survey Data, 2013

Descriptive statistics of variables in the probit model are presented in Table 3. As shown in the Table, average score of Farmers' intention to adopt GM crop (1 = intent to adopt; 0 = otherwise) was 0.37 (SD = 0.48) indicating that majority of farmers surveyed are unwilling to adopt GM crop cultivation. Also the mean age of respondents interviewed was 39.46years (SD = 10.44) demonstrating that most of the farmers surveyed were within their active labour force, with an average experience in crop farming of 10.45years (SD= 4.09). Also the farmers were generally smallholder farmers with an average land holding of 2.19ha (SD = 1.32) with crop income constituting close to half (0.48) of their annual household earnings. Generally they have low educational background with a mean schooling years completed of just 6.81years (SD = 6.05) and average household size of 10.45 persons, more than double the national average of 4 persons per household (GSS, 2012).

Farmers' knowledge and understanding of GM crop is important in assessing their adoption decision about the technology. Average basic knowledge of farmers surveyed (1= yes having basic knowledge of GM crop; 0 = otherwise) as shown in the Table is 0.64 (SD = 0.4) indicating that majority of the respondents surveyed demonstrated some level of knowledge and understanding of GM crops. This is encouraging because farmers were also generally unsatisfied with the varieties of crops they were currently growing. The study also revealed general mistrust among farmers about government policy on GM crops. Respondents with a mean of 0.65 on the statement 'mistrust of government policy on GM crops (1= yes; 0 = otherwise) indicate an expression of their general mistrust on government policy on GM crops safeguarding their interest. Inspite of the establishment of National Biosafety Authority (NBA), Technical Advisory Committee (TAC) and Institutional Biosafety Committees (IBC) as provided for in the Ghana Biosafety Act 2011 (Act, 831). As mandated in the Act, NBA is the designated national authority on all issues related to modern agricultural biotechnology in Ghana. One possible reason for this general mistrust on government policy providing protection for farmers intending to grow GM crops could be as a result of their lack of knowledge and awareness about the policy and the various institutions to be established to guide the application of genetically modified technology in agriculture.

However, farmers were positive about the GM crops cultivation improving the country's food security situation with a mean score of 0.85 on the statement 'GM crop cultivation will improve food security (1 = yes; 0 = otherwise). Also respondents were of the view that GM crops cultivation might pose health and environmental risk with average score of 0.64 and 0.63 respectively as shown in the Table 3.

Table 3: Descriptive Statistics of Variables in the Probit Model

Variable	Description	Mean	Std. Dev.
INTEN	Intention to grow GM Crop(1 = intent; otherwise 0)	0.37	0.48
GENDER	Sex of farmer (1 = Male; otherwise 0)	0.62	0.48
AGE	Age in Year	39.46	10.44
HH	Household Size (number of persons)	10.45	4.09
NEDUC	Number of Years of formal Schooling completed	6.81	6.05
RELIGION	Religious Background (1 =traditional; otherwise 0)	0.13	0.33
FARMZ	Farm Size cultivated in last season (Ha)	2.19	1.32
RATIOIN	Crop income as a ratio of household income	0.48	0.13
EXPERI	Experience in crop farming in Year	10.61	6.30
SOURINF	Source of information on GM Crops: (1 = Mass media1; otherwise 0)	0.62	0.49
LOCAT	Residential location of farmer (1＝Urban; 0＝Rural)	0.80	0.4
BKNGM	Basic knowledge on GM crops (1 = Basic Knowledge ; otherwise; 0)	0.64	0.4
TGPGM	Mistrust of government policy on GM Crop (1= yes; otherwise; 0)	0.65	0.48
SATISCV	Unsatisfied with current variety of crops (1 = yes; otherwise 0)	0.89	0.32
GMIMFS	GM crop cultivation improve food security; 1 =Yes; otherwise 0)	0.85	0.48
GMHEAR	GM Crop poses health risks (1 = yes; otherwise 0)	0.64	0.48
GMENR	GM Crop poses environmental risks (1= yes; otherwise 0)	0.63	0.49
GMMARF	GM food might be rejected by Ghanaian consumers (1= yes; otherwise 0)	0.80	0.40

Source: Analysis of Field Survey Data, 2013

3.3 Model Estimation and Empirical Results

The empirical model was found to be best fit in predicting farmers' adoption intention with LR chi-square (17) of 88.29; prob > 0.00 indicating the best fitness of the model. With adjusted R-squared of 0.77 indicating that about 77% of the variation in farmers' adoption intention is correctly predicted by explanatory variables. Estimates of parameters of the model and their marginal effects are reported in Table 4. Results of the model estimate parameters indicates that farmers 'mistrust of government policy on GM crops' and farmers' perception about possible 'environmental risks associated with GM crops cultivation' are positive and significant at both 5% and 10% levels with marginal effects of 0.38 and 0.46 respectively. Indicating that respondents who expressed their misgivings about government policy on GM crops, contrarily to apriori expectation are more likely to intend adopting GM crops, with a probability that one unit change in farmers' trust or otherwise of government policy on GM crops will produce 0.38 unit change in farmers' intention to adopt GM technology. Also farmers were intending to adopting GM crops despite harbouring the fear that GMO technology might lead to possible environmental risks with a marginal effect of 0.46 demonstrating that a unit change in farmers' perception about the environmental risks of GMO technology will lead to an almost one out of two (1/2) chances of variation in farmers' adoption intention.

The fear of environmental risks associated with the cultivation of GM crops perceived by farmers arguable may have scientific bases as observed by other studies. For example, Raybould and Cooper (2005) suggested risks of gene flow from disease-resistant crops to wild relatives and called for scheme to assess and control its replications and consequences on the environment. Other studies such as Miller and Conko (2004), Romeis and Bigler, (2006) also raised environmental risks associated with application of GMO technology in agriculture.

Religious background of farmers, crop income as a ratio of household annual income and farmers' basic knowledge about GM crops are significant at 10% significant level and positively related to farmers' intention to adopt GM crops. Indicating that, those respondents with some basic knowledge and understanding of GM crops are more likely to intend adopting the technology. This confirms early studies by Koivisto-Hursti and Magnusson, (2003) and Kenneth (2011), demonstrating the availability of empirical evidence to argue that increasing knowledge and understanding of GM technology among farmers will lead to positive adoption decision. As more farmers get to understand and increase their knowledge on GM technology, the number of farmers who will be adopting the technology is more likely to increase. The study also further revealed that farmers' basic knowledge about GM crops have a marginal effect of 0.044 as shown in Table 4, indicating that a unit change

in farmers' basic knowledge will procure 0.044 likelihood change in farmers' adoption intention. Also farmers who sourced greater proportion of their annual household income from crops are more likely to intend adopting GM crops with a positive coefficient of RATIOIN relating to intention. With a marginal effect of 0.31 indicating a variation in earnings from crops as a ratio of household annual income will cause 0.31 likelihood change in farmers' adoption intention regarding GM crops. This is quit understandable because households whose earning depends largely on crop farming enterprise will be willing to adopt innovation aimed at increasing their productive and bringing in more income.

However contrarily to apriori expectation, education which is also significant in predicting farmers' adoption intention at 10% is negatively related to intention. Farmers with more years of formal schooling were expected to have the capacity to understand and appreciate the GMO technology and the potential benefits associated with its application in agriculture and as a result will be more likely to intend adopting it. The reason for this finding could be because farmers interviewed for this study generally have low level of education with an average of only 6.8years of formal schooling completed. As such those with some level of formal education might not be that much different from those without formal educational background in terms of their literacy level and ability to diagnose and understand information on a high level of scientific innovation like GMO. However, as shown in the Table 4, variables such as GENDER, AGE, HH, FARMZE, EXPRI and SOURINF as well as LOCAT, SATISCV, GMIMFS, GMHEAR and GMMARF were not significant in predicting farmers' adoption intention.

Table 4: Probit Model Parameter estimates of farmers' Intention to adopt GM crops

	Df/dx	*Coef.*	*Std. Err.*	*z*	*P>z*
GENDER	-0.039	-0.116	0.330	-0.35	0.726
AGE	-0.002	-0.005	0.018	-0.26	0.797
HH	0.002	0.007	0.032	0.21	0.831
NEDUC	-0.014	-0.042	0.022	-1.84	0.065*
RELIGION	0.229	0.620	0.386	1.91	0.091*
FARMZ	0.018	0.054	0.127	0.43	0.668
RATIOIN	0.310	1.029	0.928	1.81	0.068*
EXPERI	-0.006	-0.0183	0.029	-0.64	0.525
SOURINF	0.086	0.264	0.327	0.81	0.420
LOCAT	-0.081	-0.231	0.502	-0.46	0.646
BKNGM	0.044	0.133	0.316	2.42	0.073*
TGPGM	0.380	1.345	0.335	4.01	0.000**
SATISCV	0.346	-0.812	0.698	-1.16	0.245
GMIMFS	0.028	0.085	0.728	0.12	0.907
GMHEAR	0.131	0.404	0.292	1.39	0.165
GMENR	0.462	1.679	0.322	5.20	0.000**
GMMARF	0.021	0.062	0.406	0.15	0.878
_cons		-2.288	1.144	-2.00	0.046**

Mean of dependent Variable = 0.365 with a Standard Deviation of 0.482
F(17, 148) = 6.55
R-squared = 0.825
Adj R-squared = 0.773
LR chi square (17) = 88.29; Prob > chi2 = 0.0000

Note: (**) indicate variable is significant at both 5% and 10%: and (*) indicate variable is significant at only 10%

Source: Analysis of Field Survey Data, 2013

4 CONCLUSION AND RECOMMENDATIONS

Notwithstanding the negative propaganda and misinformation about GM crops chained out by campaigners against GMO technology in most Ghanaian media, more than two-third of the leaders of Farmer Based Organizations interviewed intent cultivating GM crops when the Ministry of Food and Agriculture finally certified and released GM crop seeds for commercial production. Farmers who were intending to engage in the cultivation of GM crops were found more likely to have positive perception towards GM technology. They were more likely to dismiss the perception that farmers might lack the capacity to deal with the potential fall outs of GM crops, possible lack of market for GM food, commercial cultivation of GM crops will make Ghanaian farmers dependence on foreign seed companies, as well as the perception that cultivation of GM crops is a sacrilege in religious point of view. They (those farmers intending to adopt) however, were found more likely

to agreeing with the perception that cultivation of GM crops will help reduce their cost of production whilst those who do not intend to engage its cultivation dismissed the assertion. In general, both categories of respondents (those intending to adopt and those who not) were of the perception that government policy on GMO technology as captured in the Ghana Biosafety Act, 2011 (Act, 831) might not safeguard the interest of farmers in the application of the technology to promote agricultural production.

Results of the probit model estimate parameters indicates that farmers 'mistrust of government policy on GM crops' and farmers' perception about possible 'environmental risks associated with GM crops cultivation' are significant at both 5% and 10% levels in predicting farmers' adoption intention. Whilst religious background of farmers, crop income as a ratio of household annual income and farmers' basic knowledge about GM crops are significant at 10% significant level and positively related to farmers' intention to adopt GM crops. Indicating that, farmers with some basic knowledge and understanding of GM crops are more likely to intend adopting the technology.

4.1 RECOMMENDATIONS

Based on the findings of this study, it is recommended that institutions and agencies put in place to safeguard and provide direction for commercial application of Genetically Modified Technology in agriculture, such as National Biosafety Authority (NBA), Technical Advisory Committee (TAC) and Institutional Biosafety Committees (IBC) should be proactive in providing relevant information on biosafety guidelines and application procedures to farmers as potential users. They should also vigorously publicize the Biosafety Act to inform people about government policy directions on the application of Genetically Modified Technology in agriculture. This current paper had demonstrated empirically, a positive relation between farmers' basic knowledge and understanding on GMO and their intention to adopt the cultivation of GM crops. It is therefore recommended that MOFA, agricultural biotechnology research scientists and other relevant Non-governmental organizations, should help provide farmer education on application of GMO technology in agriculture. This will help increase their basic knowledge about GM crops which will go a long way to impact positively on the adoption of GMO technology when the country finally go commercial on the application of GMO technology in agriculture.

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