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THE ECONOMIC IMPACT OF IMPROVED AGRICULTURAL TECHNOLOGY ON MAIZE PRODUCTIVITY IN THE BRONG-AHAFO REGION IN GHANA

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ABSTRACT

The ability of maize farmers in Ghana to increase yield levels and attain sustainable production is largely dependent on the extent of improved agricultural methods used. Purposive sampling technique was used to obtain 270 maize farmers for the study. Questionnaire and interviews were used to collect the data. The hypotheses were tested using Chi-square. The determinants of maize output in Brong-Ahafo region of Ghana were family size, level of improved technology, farm size and the type of seed used. It is discovered that the improved agricultural technology development has a high economic impact on maize productivity as well as the socioeconomic emancipation of maize farmers from the arena of poverty. High maize productivity can be realized if the government supports and make available the use of improved maize production technologies to maize farmers. Fertilizer, tractors, agro-chemical and improved extension training should be made available to maize farmers to upsurge their produce. Also improved maize seeds should be used so as to enhance productivity.

Keywords: Agriculture, technology, productivity, economic impact.

1. INTRODUCTION

The cultivation and processing of animals, plants and other life forms of food, fiber and other by-products plays a unique role in the Ghanas' economy. Growth in Agriculture is at the heart of the economy of Ghana. This is due to the fact that increasing agricultural productivity is essential to realizing its poverty reduction and food output goals, and at the same time finding ways of reducing production costs and food prices. Maize is a very essential food in Ghana which accounts for more than 50% of the total cereal production in the country and grown in all agro-ecological zones [1]. The wholesale of maize produced goes into food consumption and it is unarguably the most important food security crop with a per capita consumption of 43.8 kg/head [2]. Despite the fact that average yield has been increasing; from 1.5 mt/ha in 2005/07 to 1.7 mt/ha in 2008/10, this capacity is below a third of the achievable yield of 6.0 mt/ha. This needs an upsurge in productivity to close the gap in order to shoot up agricultural growth. Agricultural growth can be also achieved by improving the level of technology used by farming households in maize cultivation. [3] hunts to modernize agriculture which will result in food security, employment opportunities and poverty reduction. Technology is the process by which humans

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transform nature to meet their wants. This assertion corresponds to [4] opinion that technology is the scientific study and use of mechanical arts and applied science and their application in industries.[5] also defined technology as the organized application and collective human rationality to the solution of the problems through the assertion of control over nature and all kinds of human procedures.[6]also defined technology as an organized measurement for some purposive activity. The assertions above suggest that agricultural technology includes processes of agricultural production. These processes include; the introduction of new crops, production of plant and animal breeding (including biotechnology), livestock and fisheries, mechanization, infrastructural development and inputs. As per [7,8] directives, Ghana is to allot 10% of government expenditure to attain an agricultural gross domestic product (GDP) growth of at least 6% yearly to meet the millennium development goal 1 (MDG1) of reducing poverty and hunger. Agriculture in Ghana accounts for over 30% of the nation's GDP [2] and three-quarters of the country's export earnings. Yields of most crops in Ghana however are generally low, 20% to 60% below their feasible level. Fast-tracked growth in agriculture needs to be driven by improved productivity like the Green Revolution in Asia rather than a mere land extension. Possibility for such productivity-led growth exists in Ghana. This is demonstrated by significant gaps amid current and achievable yields for many crops. The main reasons for the low productivity yield per hectare (yield/ha) of maize include wide use of unimproved maize seeds, lack of soil fertility, irregular rainfall, commonness of pests and diseases, minute improvement in agronomic technologies, inadequate use of yield-enhancing inputs such as fertilizers and agrochemicals [9]. Agricultural productivity can be enriched through the development and adoption of new technologies or through the effective use of the present technologies without damaging the natural resource base [10]. The mechanization of farm operations is a vital step toward growing production efficiency [11]. According to [2] baseline survey, about 40% of farmers use various methods of mechanization.; The use of tractors in land preparation decreases technical inefficiency because there should be timely land preparation and planting. Maize is a very important staple food in Ghana accounting for more than 50% of total cereal production in the country and grown in all agro-ecological zones [1]. The majority of maize produced is consumption[12] and it is unarguably the most important food security crop[13]. Maize, otherwise known as corn, it is central to the economy due to its varied range of uses[14]. Maize is principally used as feed for livestock, signifying the dependence of the livestock industry on maize production. It is also used to create a range of food and non-food products, such as corn meal, sweeteners, corn oil, starch and ethanol, which is used as a cleaner-burning alternative to gasoline[15,16]. The capability of maize farmers in Ghana to expand yield levels and reach viable production is dependent on the efficient farm practices, hence technical[17]. Farmers must be educated about enhanced practices to reduce waste and for well utilization of the resources at their disposal[18]. Farming in Ghana is fundamentally a risky business because of unpredictable weather and prices[19]. Implementation of technological innovation in agriculture has fascinated significant attention among development economists. Mainstream of the population of under-developed and developing nations originate their livelihood from agricultural product and because new technology apparently offers opportunity to increase production and income substantially[20]. The main

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objective of this study is to analyze the economic impact of improved agricultural technology on maize production in the Brong-Ahafo region in Ghana. The economic impact of improved agricultural technology can be felt on maize productivity, if the improved agricultural technology development reaches the maize farmers through extension and other means. Even though a number of agricultural technology studies have been done in Ghana and elsewhere, improved Agricultural technology is time, location and even crop-specific[21]. This raises the research questions, what are the levels of technology adoption in maize production in Brong-Ahafo region in Ghana and what factors influence such levels? Bearing in mind the huge number of Ghanaians who grow and eat maize, if there is an improved technology, there is going to be an increase in the productivity of resources devoted to maize production which will bring about real income gains for the majority of the population. Increases in productivity results in lower prices for maize, the income gains will also be delivered on to other urban inhabitants.

2.LITERATURE REVIEW

Agriculture plays a distinctive role in decreasing poverty through the use of technologies[22,23]. According to the [24,25], Agriculture is an important livelihood source for about 75% of people surviving on less than $1 a day. Seventy percent of Sub- sahara African's labour force and 67% of South Asians are employed in the agricultural sector. [26]. Development in agricultural productivity has a powerful knock on effect to the rest of the economy through input supply and the supply of affordable food which stimulates and support economic growth and development[27].Technology advancement in agriculture arose at least 10,000 years ago [28]. Earlier in civilization, the technical performance of agriculture in the great civilization continued unevenly equivalent for centuries until the middle of the nineteenth century, where principally in Europe and North America, the introduction of new technology into agricultural activities[29]. The improvement in agricultural technologies has since then been very inspiring, particularly in improved "modern varieties" (MVS) of grains. In 1990 modern varieties (MVS) signified an estimated 75% of Rice, 70% wheat and 57% of the maize growth in the developing world. Although these figures revealed part in the Green Revolution package of seed, fertilizer, irrigation and a substantial proportion of these (MVS) grown with little or no external inputs [30]. This story is not narrowed to cereals only, new technologies have also been established for non- cereals and many MVS have been developed principally for their resistance to pests and diseases in other areas outside cereals. The research undertaken in Nigeria in the 1970 was fundamentally for the development of cassava resistant to mosaic virus [31]. According to [32] the link between risk and technology use is a recurrent melody. It can labor in two orders. First, the adoption of agricultural technology can make a limited contribution to plummet the vulnerability of the small scale farmers who are generally poor. Maize occupies an exclusive position in the world food economy particularly its survival ability where other crops fail. Secondly, it provides a satisfactory yield on a varied sort of soil types. There can be compromises amid growth through agricultural technologies and risk since taking up a new agricultural technology is risky by nature. While improved productivity through improved agricultural technology may result in increased income, taking on is related with capital and

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transaction cost that poor farmers cannot manage to pay for. Regardless of the distribution of fund by the Federal government to agricultural sector over the years and the technical support from international fund for Agricultural development (IFAD), proof has shown that the agricultural industry does not appreciate the place it was in the Gross National Product (GNP) of the Ghanaian economy. Increase in maize productivity will increase per capita income of the citizens and enhance the wellbeing of the citizens[33,34,35]. To achieve this, all the constraints leading to declining farmer's performance in the production must be dealt with[35]. While some of the constraints are enacted by the government's inability to live up to expectation, the other is carried out by the multifarious nature of the society. A research was conducted to investigate into factors related to the adoption of improved farm practices in Nigeria and the findings showed technology adoption was positively and significantly related with the farmers' age, level of education , social status, location, sizes, credit, improved technology itself in terms of relative advantage compatibility, complexity and availability, participation of voluntary organization and Characteristics of change agents in terms of their personal attributes, techniques of communication, amount of participation obtain and the use of traditional culture[36]. The major problem with the adoption of improved agricultural technology by farmers in Nigeria as observed by [36]is inadequate finance. [37]sees finance as an issue vital to entering the processing and buying of farm inputs like herbicides, insecticides, and fertilizer in farming of which maize is inclusive. Effective management of maize farmers toward higher productivity is a function of the availability and level of finance or credit facility at the maize farmers' disposal. Also, maize farmers are confronted with the problem of land tenure system. This is because land for agricultural production is mainly attained by inheritance or within the extended family. This problem of land tenure as observed by [38] raids a lot of people who are attracted in the cultivation of maize the opportunity to do so which now shift their interest to other sectors of the economy. Alternatively,[39] a number of land owners feel it is unfair and dishonest to sell their land to farm users because this may withdraw their future generation of the inheritance prospect. Low level of literacy among maize farmers is another major problem. Most of farmers are those who live in the rural areas and are mostly uneducated. This has an opposing effect on the role these farmers play in their various economic activities. [40] detected that the level of education of farmers plays a vibrant role and quickens the assumption rate of farmers in case of new technology, [41] recommended that education is supposed to help develop managerial skills which lead to higher adoption index and adoption is positively related to education. Research has shown that the age of a farmer plays a substantial part in his or her adoption decision. Most of the studies carried out in Ghana shows that more youths respond to innovation than the older ones. This is because the most of the youth are educated. In spite of the accelerating number of research work carried out on maize productivity, few research works have been carried out on the assessment of the Economic Impact of improved agricultural technology Development on maize productivity in Ghana in recent time.

[42] conducted a research work in similar area but in their work, they placed emphasis on Measuring Farm and Market Level Economic Impacts of Improved Maize Production Technologies and also their studies took place in Ethiopia. Also [43] conducted a study which focused on the impact of improved maize varieties on farm productivity and wellbeing: evidence

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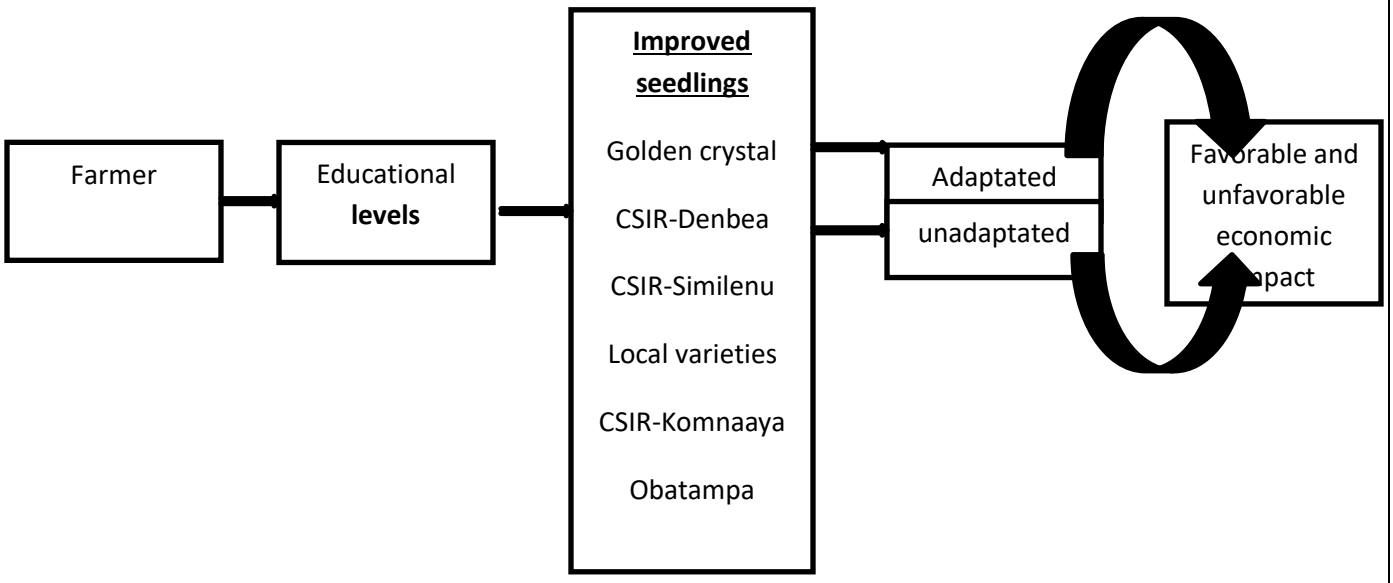
from the east Hararghe zone of Ethiopia. It was concluded that adoption of improved maize varieties leads to significant gains in wellbeing and improves farm productivity. Furthermore, [44] conducted a work on the topic assessing the technical efficiency of maize production in northern Ghana. Their data were collected between January and February, 2013 in the three regions (Northern, Upper East and Upper West) of northern Ghana for the 2011/2012 cropping season. Their data collection was carried out in six districts, two districts in each of the three regions. Multi-stage sampling methods were used in identifying a district where six communities were randomly selected in each district. All the above are similar studies but some were conducted in different countries and the conducted in the same country took place in different regions with different population sizes and different data collection techniques. These insufficiencies have incited the researchers to seal this gap by assessing the economic impact of improved agricultural technology on maize productivity in Ghana.

[45]Each and every farmer has his or her educational level. The ability for farmers to adapt to the use of the improved seedlings is highly dependent on the educational level. If the farmer adapt to the usage of improved seedlings, it will bring about favorable economic impact and if the famer fails to adapt to the usage of the improved seedlings, the probability of resulting in unfavorable economic impact is high[46].



Conceptual framework

3.METHODOLOGY

The study was carried out in the Brong Ahafo region of Ghana. The Brong-Ahafo Region is located in south Ghana. Brong-Ahafo is bordered to the north by the Black Volta River and to

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the east by the Lake Volta, and to the south by the Ashanti, Eastern and Western regions. The Brong-Ahafo region has (22) districts. The region experiences two major seasons, dry and wet seasons which favors the growth of varieties of food and cash crops. The major economic activities of the people are farming, fishing, services and government employees and the major crops grown are cocoa, maize, yam, cassava, oil palm and cashew. The population for the study is maize farmers in Brong-Ahafo region, Ghana who are members of maize farmers association in the region. Out of the 22 districts, 9 districts were selected for the study using the purposive sampling technique. Data were sourced from primary sources. Data from primary sources were collected with the aid of well-structured questionnaire and oral interview.

Table 1: Sample selection

Districts	Number of respondents
Sunyani Municipal District,	30
Tano North District, DUAYAW-NKWANTA	30
Tano South District, BECHEM	30
Asunafo North District, GOASO	30
Dormaa East District, WAMFIE	30
Dormaa District, DORMA AHENKRO	30
Asutifi District, KENYASI	30
Techiman Municipal District, TECHIMAN	30
Berecum District, BERECUM	30

Source: Field survey, 2018

Data collected from the field through the use of well-structured questionnaire were subjected to analysis using the frequency of occurrence, percentage of occurrence and the mean of the population. In other to empirically test the hypothesis of the study, the chi-square was employed.

Analytical Framework and Estimation Techniques

A farmer's decision to adapt to technology is based on his or her expected benefit. A normal farmer is expected to adopt any new technology if the benefit from adoption is greater than if there is no adoption. If we let the gain from adoption of technology to be H*, then H*>0 implies that the benefit from technology adoption is greater than if there is no adoption. Clearly, it is

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impossible for us to observe H*, yet, we can express it as function of observable vector of covariates in a latent model presented below:

$H_t^* = \emptyset R_t + \omega_t H_t = 1[H_t^* > 0]$ (1)

Where H_t is a binary indicator variable which equals 1 if the farmer is adapts to technology and 0 if otherwise. $\emptyset$ is a vector of parameters to be estimated, and $R_t$is a vector of farmer's socio-economic characteristics, farm level and institutional variables and ω_t is an error term assumed to be normally distributed. The probability of adoption of technology can be expressed as:

$\Pr(H_t = 1) = \Pr(H_t^* > 0) = \Pr(\omega_t > -\emptyset R_t +) = 1 - F(-\emptyset R_t)$, (2)

F is the cumulative distribution function for ω_t. Different models such as logit or probit can be used to estimate equation (2) depending on the assumption made about the functional form of F. The adoption of technology is expected to lead to upsurge in productivity, decrease food insecurity and poverty. We can link the decision to adopt with our expected outcomes, by considering a farmer that is risk-neutral with the ultimate aim to maximise his or her net revenues, subject to competitive input and output markets and a single-output technology that is quasi-concave *I* the vector of variable inputs, *U*. This explanation can be expressed as follows:

$Max\pi = PQ(U, R) - I' U$ (3)

'P' is the output price and Q is the expected output level; 'I' is a column vector of input prices, whereas 'U' is a vector of input quantities and R represents farm level and household characteristics. The farm net returns can be expressed as a function of technology choice H, output price, variable inputs and household characteristics as follows:

$\pi = \pi (H,I,P,R)$ (4)

The reduced form equations for the input and output supply can be obtained by applying Hotelling's Lemma to equation (3) as follows:

$U = U (H,I,P,R)$ (5)

$Q = Q (H,I,P,R)$ (6)

The specifications in equations (4) to (6) reveal the choice of technology, input and output prices, as well as farm and household characteristics tend to influence farm net returns, demand for input and level of farm output. The relationship between technology adoption, food security and poverty reduction can be expressed as follows:

$W_t = \emptyset_0 + \emptyset_1 H_t + \emptyset_2 R_t + \psi_t$ (7)

W_t is a vector of outcome variables for household 'I', including food security and poverty status of the household. R_t is the household demographic characteristics, and $\psi$is an error term, with ψ_t . There is a problem of selection bias if the error term (ψ_t) in the technology choice equation (1)

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and the error term (ψ_t) of the outcome equation (7) are correlated and when this correlation is more than zero.

The paper is based on the following hypothesis: 1. Improved maize seedling has a favorable relationship with farmer's output. 2. There is a significant relationship between farmer's educational level and the degree to which they will adapt to the usage of improved seedlings.

4.RESULTS AND DISCUSSIONS

Table 2: socio-economic and demographic characteristics of respondents

Variables	Frequency	Percentage
Sex		
Male	190	70.37
Female	80	29.62
Age in years		
20 – 30	45	16.66
31 – 40	120	44.44
41 – 50	70	25.92
51 and above	35	12.59
Marital status		
Single	70	25.92
Married	150	55.55
Divorced	50	18.51
Education level		
No education	80	29.62
Primary school	110	40.47
Secondary school	60	22.22
Tertiary education	20	7.40

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Source: field Survey Data, 2018

Table 2 depicts the socio-economic and demographic characteristics of the respondents. Majority of the respondents represented in this study are male (190;70.37%) this gives an indication that the responses will be more of male views than female. Also most of the respondents are between the ages of 31-40 (120;44.44) with few above 50 years. This shows that most farmers in the Brong-Ahafo region constitute the youth because of the physical nature (needs more physical strength) of farming in Ghana. Furthermore more than a half of the total respondents are married and therefore they need to provide food for themselves and the family. It was also revealed that out of the 270 respondents, 110 are primary school leavers with few having the tertiary education. This means that most of the farmers are not well educated. The result affirms the work of [47].

Table 3: Family Size of Respondents

Family Size	Frequency	Percentage
1 – 5	100	38
6 – 10	90	33
11 – 15	60	22
Above 16	20	7
Total	270	100

Source: field Survey Data, 2018

According to table 3, most farmers prefer to live with a family not more than 5 people. Significantly a number of farmers also prefer a family between 6-10 people with few preferring over 16 people in their family. This is because the larger the family size, the more the farmer needs to work to feed them and get excess for sale.

Table 4: **Type of Improved Varieties used by the Respondent**

Maize varieties	Frequency	Percentage
Golden crystal	75	28
CSIR- Denbea	70	27

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CSIR-Similenu	60	22
Local varieties	25	9
CSIR-Komnaaya	20	7
Obatampa	20	7
Total	270	100

Source: field Survey Data, 2018

With reference to table 4, farmers prefer using the golden crystal improved maize closely followed by the CSIR- Denbea and CSIR-Similenu. Farmers gave the reason that, these maize varieties take a lesser time to get ready for harvest and they yield more as compared to local varieties. Farmers further gave a reason that, these varieties are easy to preserve for future use and take a long time before they get spoilt. Therefore 91% uses the improved varieties as compared to the local varieties of 9%.

Table 5: Farming Tools used by the Respondents

Tools	Frequency	Percentages
Cutlasses	200	74.07
Tractors	50	18.51
Animals	1	0.37
Others	19	7.03
Total	270	100

Source: field Survey Data, 2018

From table 5, it can be seen that, most of the farmers prefer using cutlasses for farming. This is because of the primitive nature of farming in Ghana[48]. The level of education of most farmers is low therefore difficult for them to desist from using the primitive tools in farming. Farmers

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also stated that cutlasses are cheap, readily available, easy to maintain while the rest who use tractor opined that they are more efficient and saves time and energy.

Table 6: Respondents' Operational Cost of Production per hectare before and after Adoption

Inputs	Cost per hectare in cedis before adoption	Cost per hectare in cedis after adoption
Land clearing	50	34
Fertilizers		120
Planting	20	20
Weeding	43	44
Cultivating	55	44
Processing	34	44
Harvesting	48	44
Total	250	350

Source: field Survey Data, 2018

Table 4 shows that 91% of the respondents adopted the use of improved variety and local varieties have about 9% respectively. From Table 5; Majority of the respondents who use and cutlasses stated that, the tools are cheap, readily available, easy to maintain while the rest who use tractor opined that they are more efficient and saves time. This finding is in accordance with [28] observation that tractors are used by few rich farmers. Table 6; shows the cost of production before and after adoption of the improved technology, where it was observed that the farmers spend less on maize production before adopting the improved technology. The result also revealed that farmers invested more resources in farming after adapting to technological improvement. This is because the cost involved after the adaption is far lower than the earlier.

Table 7: Revenue of the respondents before and after the adoption of the improved Agricultural technology.

Variables	Revenue before the adoption in cedis	Revenue after the adoption in cedis	Net revenue in cedis
Cost of production	250	350	Income the adoption

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Maize yield per hectare	4.5 tones	10.75	87.5
Price per tone	75	75	Income after adoption
Gross revenue	4.5 x 75 = 337.5	10.5 x 75 = 787.5	437.5
Net revenue	337.5 – 250 = 87.5	787.5 – 350 = 437.5	437.5- 87.5 = 350

Source: field Survey Data, 2018

From table 7, it can be deduced that, the revenue of maize farmers after the adoption of improved technology is higher than before the adoption. This gives an indication that using improved agricultural technology in farming yields more revenue that using primitive methods[49,50].

Table 8: Chi-square Tests of the Economic Impact of Improved Agricultural Technology on Maize Productivity in Brong-Ahafo region in Ghana

FO	**FE=RT x CT/N**	**FO – FE**	**$(FO – FE)^2$**	**$(FO – FE)^2/FE$**
37	44.2	-5.2	27.04	1.073
27	21.8	5.2	27.04	2.759
77	73	4	16	0.444
17	21	-4	16	1.143
37	35	2	4	0.222
10	14	-4	4	0.571
41	40.6	0.4	0.16	0.007
13	13.4	-0.4	0.16	0.019
20	21.2	-1.2	1.44	0.2
4	3.8	1.2	1.44	0.514
				= 6.952

DF = (r - I), (c - 1), = (4 - 1), (2-1) = 3, Alfa = 0.05 $x^2t = 2.353$

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Chi-square calculated = 6.952 and Chi-square tabulated = 2.352, Since the Chi-square tabulated is less than the calculated [x^2t (2.352)<x^2c(6.952)], it can be concluded that there is a significant impact of improved agricultural technology Development on Maize productivity in Brong-Ahafo region in Ghana.

5.CONCLUSION, RECOMMENDATION AND POLICY IMPLICATION

This research work assesses the economic impact of improved agricultural technology on maize production in the Brong-Ahafo region of Ghana. Questionnaire and interviews were used as the data collection instrument. Regarding the purpose of the study, 270 respondents from nine districts were selected, using the members of maize farmers association as sample frame. From the results, it is discovered that the improved agricultural technology development has a high economic impact on maize productivity as well as the socioeconomic emancipation of maize farmers from the arena of poverty. High maize productivity can be realized if the government supports and make available the use of improved maize production technologies to maize farmers. Fertilizer, tractors, agro-chemical and improved extension training should be made available to maize farmers to upsurge their produce. Also improved maize seeds should be used so as to enhance productivity.

The result of this research affirms to the findings of (Adofu et.al 2011)[51,52] that improved agricultural technology has aided in increasing agricultural productivity. With increase in scientific research, pronounced varieties of philosophies have been produced and made available to Ghanaian farmers. These new philosophies are called technologies. These technologies are used as working parameters to associate the inputs which enable farmers to increase their output and produce a high income, food, provide employment and also increasing the their propensity to save. [53] contends that no other sector than agriculture offers the same likelihoods to spawn employment. Indubitably the adoption of improved agricultural technologies results in increase in productivity in diverse parts of the world. The government of Ghana in its commitment to upsurge food production, rising farm incomes and improve the standard of living of the farmers in the country as well as increasing agricultural productivity of the farmers, sought assistance from banks and other institution to increase productivity of maize. This is evidenced in the use of improved varieties; improved disease control, drought resistant and pest control as well as enhanced agronomic practices. Other benefits include the introduction of better-quality processing method and better-quality storage facilities. Increased maize productivity leads to national food security and exciting rural economy, which will significantly increase per capita income of the citizens in the country. To achieve this, a logical grassroots methodology that would take advantage of low cost of information dissemination inherent in the particular rural settings of the participants for the purpose of increasing maize productivity through the adoption of improved agricultural technology should be prime.

Agricultural Development Programme (ADPs) should focus on farmers other than their present concentration of being profit centered. There is need to educate young Ghanaians to take a look into agriculture and particularly to growing of maize since it has been established in this study to

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be a high remunerative crop enterprise for those who adopted and sustained the use of the suggested practices. Government policies on import and manufacture of agro-chemicals should target at providing those chemicals that are supreme useful, affordable and favorable to the environment. Farmers should avail themselves to the available improved technologies in order to increase their production and welfare. There is need also to sustain the adoption of improved technologies over time by means of ensuring a positive and significant impact of improved technologies. Measures to sustain adoption of improved technologies include investments on irrigation use, water conservation technology and drought tolerant crop varieties, which raises the need for further research in these areas of study.

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