IJAAR PUBLISHING®
DOI: 10.46654

International Journal of Advanced Academic Research | ISSN: **2488-9849**
Vol. 7, Issue 7 (July, 2021) | www.ijaar.org

CORRELATION BETWEEN ADOPTION INDEX, COST AND OUTPUT AMONG MAIZE FARMERS

[1]Dalla, A.; [1]Mailumo, S.S.; [1]Holi, H. and [1]Onuwa, G.C.*

Department of Agricultural Extension and Management, Federal College of Forestry, Jos, Plateau state, Nigeria.

*Corresponding author: onuwag@gmail.com (08035606473)

Abstract

Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demands. This could be attributed to low productivity from maize farms due to non-adoption of improved technologies for maize production by farmers. This study analyzed the correlation between adoption index of production technology, adoption cost and output among maize farmers in Toro local Government Area of Bauchi State, Nigeria. Multistage sampling technique was adopted for this study. Primary data collected were analyzed using descriptive statistics (frequency distribution and percentages), adoption index and multivariate correlation techniques. Findings from the study revealed the production technologies adopted among maize farmers, they include; adjustment in planting date (74.3%), use of improved seed varieties (70.3%), planting spacing (60.4%) use of agro chemicals (59.4%) and pest management and disease control (50.5%). Furthermore, the results revealed that most (61.4%) of the farmers have low adoption index of ≤0.39. In addition, the results revealed that there was a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index). The estimated correlation coefficients for r_{xz}, r_{yz} *and* r_{xy} *were -0.65, 0.52 and 0.58 respectively. Subsidizing cost of production technologies, improving access to agricultural technology, credit, extension contact, labour supply and tenure policy modifications are strongly recommended to ameliorate adoption constraints.*

Key words: Adoption cost, adoption index, agricultural technology, correlation, yield, maize production

1.0 Introduction

Maize (Zea mays) is a cereal produced across the world. Maize is one of the most important cereal crop cultivated in the rainforest and derived savannah zones of Nigeria. Maize has now risen to a commercial crop on which many agro-based industries depend on as a raw material (Iken and Amusa, 2004). It is a high yielding crop, easy to process, readily digested with cost advantage when compared to other cereals (IITA, 2001). It plays an important role both in terms of food security and nutritional intake and accounting for about 43% of calorie intake with a daily consumption quantity of 53.20g per capita (Komolafe *et al*., 2010). It is also used extensively as the main source of calories in animal feeding and feed formulation (Manyong *et al*., 2005). Apart from feed and food, maize is also useful in medicines and as raw material in agro-industries (Abdulrahaman & Kolawole, 2006). It constitutes a staple food in many regions of the world particularly in developing countries (Abebaw and Abelay, 2001). Maize is a staple food of great economic importance in the sub-Saharan Africa of which Nigeria is inclusive. In Nigeria, it is the third most important cereal crop after sorghum and millet (Ajayi *et al*., 2008). Maize is used as a staple human food, as feed for livestock and as raw material for many industrial products (Ouma *et al*., 2002). In most countries, maize is the most important foodstuff and in particular provides the daily bread for indigenous population of rural communities. Frova et al (1999) asserted that maize is one of the world's three most important cereal crops after wheat and rice and it has the widest distribution of any cereal. According to them, the crop is primarily grown for its grain which is consumed as human foods. In some developed countries, maize is also grown for animal feed and as a base for industrial products such as oil, syrup and starch. Maize is the second most important cereal crop in the world in terms of acreage and production. Global production of Maize was about 1040 million MT in the year 2016–2017, wherein USA and China contributed about 38 and 23%, respectively. Maize can be cultivated successfully in loamy sand to heavy clay, well aerated, neutral pH soils. As of tropical origin, it is highly sensitive to water stagnation, so avoid the cultivation in low-lying or poor drainage fields. Furthermore, extended low temperature less 5°C severally affects the crop. Optimum range of temperature for better crop growth and yield realization is 25–35°C. Maize crop can be cultivated throughout the year with high yield levels. The average yield of maize in Nigeria is about 2500–3500 kg/ha of threshed grain using recommended fertilizers, varieties, seed-dressing, and improved cultural practices. The total land area planted to maize in Nigeria is above 2.5 million hectares with an estimated yield of about 1.4 metric tons per hectare, though, maize production is still very low especially if considered in relation to the growing food demand of the country. About 20% is processed for secondary uses.

Growth in maize utilization has been driven by the rapidly increasing demand for maize as livestock feed, food and industrial non-food products. The population of Nigeria is expected to grow at a rate of more than 3% per year, while food production is likely to grow at a rate of 2% or less a year. Closing this gap and increasing food production will require intensive agriculture based on use of modern technologies such as the use of improved seed varieties, agrochemicals, management practices, etc. Higher solar radiation received in the northern part of the country relative to the southern part, increases the potential of maize production in the northern zone (NAERLS & FDAE, 2014). Improved agricultural practices are farming practices that have been researched on, tried and found to bring about increased crop yield (Ali-Olubandwa et al. 2010). The practices include use of certified seeds, agronomic practices, fertilizer and agrochemical application among others. Ouma *et al*. (2002), defined adoption as a decision to make full use of an innovation or new technology as the best opportunity available to the farmers. In view of the uncertainty about the outcome or otherwise profitability of such innovation, a greater effort is required of the farmers so as to decide whether to use the innovation or not. Agricultural productivity in the developing countries like Nigeria continues to be low and it is generally believed that non-adoption of research results by majority of farmers is the main reason for this situation (Idrisa *et al*., 2012). Bawa and Ani (2014), found a positive and significant association between ages, farming experience, training received, socio-economic status, cropping intensity, economic motivation, innovativeness, information sources, utilization, adoption, etc. However there has been a fluctuating trend in maize production over the last decades which threatens household. Maize has yielded compelling success stories with the adoption of new technologies that has increased small holder maize production. The diffusion of new technologies in Africa has been more widespread for maize than for other food crops. This implies that technologies adoption can provide a basis for further increase in maize production. Farmers' efficiency in maize production resulting from technological innovations also has some food security implications. Food crisis is more serious in sub-Saharan Africa where the attainment of food security is intrinsically linked with poor agricultural techniques which results in decrease in agricultural growth rate (Ajayi *et al*., 2008). Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demands. This could be attributed to low productivity from maize farms due to non-adoption of improved technologies for maize production by farmers. Therefore the study intends to evaluate the adoption of production technologies by maize farmers in the study area. To this effect, the following research questions would be asked;

i. What were the maize production technologies adopted?
ii. What is the adoption index of production technology among the respondents?
iii. What is the correlation between adoption cost, adoption index and farm output?

1.1 Research Hypothesis

H_0: There is no significant relationship between adoption cost, adoption index and farm output**.**

2.0 METHODOLOGY

2.1 Study Area

Toro Local Government Area (LGA) covers a total land area of 6932km^2 and a total population of 350,000 people, projected at 3% growth rate per annum to be 499,586 in 2018(NBS, 2006). The local government shares common boundaries with Plateau in the Southeast, Kaduna in the West and Kano in the North. Toro local government is topographically hilly with altitude of 100m above sea level. It is located on longitude 9°N and 12°E and latitude 8°N and 11°E. It is in the Sudan Savannah zone of Nigeria with an average rainfall ranging between 830mm to 1,100mm annually starting from April to October, with average temperatures of 35°C for lowland and 31°C for highland areas respectively (NBS, 2006). There are three major districts that make up the local government: Toro district with headquarters at Toro, Lame district with headquarters at Gumau and Jama'a district with headquarters at Nabardo. The populations are predominantly farmers and the crops grown in the local government include: maize, rice, cowpea, sweet potato, sorghum and soya beans.

2.2 Sampling Techniques

A multistage sampling technique was employed to select maize farmers in the study area. At first stage, Toro Local Government Area was selected. The next stage involves a purposive selection of the three district of the Local Government. The three districts selected are Toro, Lame and Jama'a. The third stage involves a simple random sampling of two villages from each district. In the last stage, from compiled lists of maize farmers 10% respondents from each village was selected which gave an overall sample size of 101 respondents. Table 1 presents the sample frame distribution.

Table 1: Sample Size of the Respondents

District	Village	Sample Frame	Sample Size
Toro	Zaranda	189	18
	Takanda	164	16
Lame	Magamagari	150	15
	Babikko	160	16
Jama'a	Zalau	173	17
	Rishi	190	19
TOTAL		1026	101

Source: Field Survey, 2019

2.3 Method of Data Collection

The data collected for this study was obtained from primary sources. The primary data for this research was collected through the use of well-structured questionnaires.

2.4 Analytical Techniques

Data for the study were analyzed using descriptive statistics (frequency distribution and percentages), adoption index and multivariate correlation techniques. The null hypothesis was tested using the results from the multivariate correlation analysis.

2.4.1 Model Specification

Adoption index

The index of adoption of maize production technologies was measured using the adoption index. Adoption index was computed for individual farmer following Philip *et al*., (2000) whereby adoption index (Bi) is given by:

$B_i = \sum (R_i/R_T)$ ……………….. (1)

Where:

B_i = the adoption index of maize production technologies by i_{th} farmer;

R_i = number maize production technologies adopted byi_{th} farmer; and

R_T = Total number of maize production technologies available to the i_{th} farmer.

i = (1………….n)

For this study, adoption index of ≤0.39 indicates low adoption index, while index of ≥0.4 indicates high adoption index.

Some of the recommended maize production technologies available in the study area include;

i. Adjustment in planting date;
ii. Planting method and seed varieties;
iii. Plant spacing and seed rate;

iv. Weed management;
v. Harvesting technology;
vi. Fertilizer application and management;
vii. Pest management;
viii. Postharvest Processing techniques;
ix. Storage methods;
x. Water management; and
xi. Disease control.

Multivariate Correlation Analysis

The correlation analysis was used to analyze the multivariate relationship between adoption cost (x), adoption index (y) and farm output (z), where multiple correlation coefficients (R, r) are defined in equation (1); following Gujarat, 2004 whereby:

$Rz, xy = \sqrt{r^2_{xz} + r^2_{yz} - 2r_{xz}\,.r_{yz}\,.r_{xy} / 1 - r^2_{xy}}$…….. (1)

Rz, xy= multiple correlation coefficient between dependent and independent factors;

z= dependent variable z;

x= independent variable x;

y= independent variable y;

r^2= coefficient of determination;

r^2_{xz} = coefficient of determination between x and z;

r^2_{yz} = coefficient of determination between y and z;

r^2_{xy} = coefficient of determination between x and y;

r_{xz}= correlation coefficient between x and z;

r_{yz}= correlation coefficient between y and z; and

r_{xy}= correlation coefficient between x and y.

Also, the strength of relationships based on the correlation coefficient (r) is expressed as follows;

i. ≥ +/-0.7 (strong linear relationship);
ii. +/- 0.4 - 0.69 (moderate linear relationship); and
iii. ≥ +/-0.39 (weak linear relationship).

3.0 Results and Discussion

3.1 Maize Production Technology

Table 2: Distribution based on Maize Production Technologies Adopted

Technology	Adopted	Not adopted	Ranking
Adjustment in planting date	75 (74.3)	26 (25.7)	1st
Planting method and seed varieties	71 (70.3)	30 (29.7)	2nd
Plant spacing and seed rate	61 (60.4)	40 (39.6)	3rd
Weed management	60 (59.4)	41 (39.6)	4th
Harvesting technology	51 (50.5)	50 (49.5)	5th
Fertilizer application and management	49 (48.5)	52(51.5)	6th
Pest management	43 (42.6)	58(57.4)	7th
Postharvest Processing techniques	41 (40.6)	60(59.4)	8th
Storage methods	35 (34.7)	66 (65.3)	9th
Water management	28 (27.7)	78 (77.3)	10th
Disease control	15 (14.9)	86 (85.1)	11th

Source: Field Survey, 2019; Percentages are in parenthesis

Table 2 revealed the various production technologies adopted by maize farmers in the study area. The significant production technologies adopted among maize farmers include; adjustment in planting date (74.3%); due to occurrence of diverse climatic conditions in the country, planting time varies from place to place. The optimum time to sow the crop depends on availability of irrigation facilities. For example, if irrigation facilities are available, maize crop can be sown during all seasons, planting method and seed varieties (70.3%); Method of planting plays an important role in establishment of crop under given set of conditions. Maize is mainly sown directly through seed by using different methods of tillage & establishment. Recently, resource conservation technologies (RCTs) namely; zero tillage, minimum tillage, ridge/raised bed planting, furrow planting and flat sowing of maize crop have been adopted by farmers in various maize based cropping system and are cost effective and environment friendly. Cultivars or seed varieties can be proffered based on length of growing season, availability of optimum moisture regime etc., plant spacing and seed rate (60.4%); the plant spacing recommended for maize in the Nigerian savannas is 75 × 50 cm, where 2 plants per stand are adopted. Maize may be planted either manually (hand planting) or mechanically. Crop geometry has direct effect on inter and intra-plant competition in field crops. Maize crop can be planted in varied crop geometries depending upon the purpose of cultivation. About 15–20 kg of maize seeds is required to plant a hectare, which is about 2½ acres. Plant 3 seeds per hole and later thin the stand to 2 plants at about 1–2 weeks after germination. When maize is grown as an intercrop, the spacing should be wider than for sole cropped maize. The practice of alternating rows of maize with other crops is highly recommended as it will allow the adoption of recommended packages for each crop. Being a non-tilling crop it cannot compensate for the lost space if proper plant stand is not maintained under field conditions. So maintenance of 60–65,000 plants/ha is pre-requisite for realizing maximum yield. Sowing of the crop should be done 60 × 20–25 cm crop geometry, weed management

(59.4%); Good control of weeds in maize is a prerequisite for high yield. Weeds usually compete with the crops for nutrients, sunlight, and water. To permit the maize crop to express its full potential on the field, regular weeding is necessary. Timely weeding is essential, especially at the early stages of growth. Since the crop is shallow-rooted, it is very important to ensure that no mechanical damage is done to the crop roots during this operation. In cases where soil erosion is becoming significant, earthing up or remolding of ridges will be essential to prevent lodging and excessive exposure of the roots to the sun. In many parts of the Nigerian savannas, Striga is a notorious parasitic weed that has continuously posed a great threat to maize production. Under severe infestation, even before the emergence of Striga, the maize plants are usually severely attacked and look yellowish, stunted, and wilting. To effectively control Striga, the various methods need to be implemented in an integrated way and should include rotation with soybean, use of tolerant/resistant varieties, and application of the recommended fertilizer rate, with other cultural practices. Manual weed control weeding may start as much at 2 or 3 weeks after planting, and more than 2 manual weeding may be required. Two manual weeding are recommended to be conducted at 2 weeks and 4–5 weeks after planting. In areas where Imperata cylindrica is a problem. Chemical weed control wherever economically feasible to do so, herbicides can be used to control weeds on a maize farm. Although some have been recommended for sole cropped maize, it is important to note that the effectiveness of the herbicides is enhanced by very good land preparation, whatever implements are used. The increasing problem of lack of appropriate labor has increased the adoption of chemical weed control. Before land preparation, application rate will depend on formulation and label rate. Wait for 10 days after application before land preparation. Maize crop is infested with grassy and broad leaf annual weeds. Among grassy, *Dactyloctenium aegypticum*, *Eleucine indica*, *Setaria glauca*, *Cyanodon dactylon*, *Cyperus rotundus*, *Sorghum helepanse*, *Bracharia rapens* are common. The broad leaf weeds are *Celosia argentia*, *Commelina bengalensis*, *Phylanthis niruri*, *Solanum nigrum*, *Amaranthus viridis*, *Trianthema partulacastrum*. Effective weed management strategies have key role in successful maize cultivation. Adoption of weed control practices during the first 6–8 weeks after planting is crucial because maize crop kept weed free for 30–45 days after planting is almost similar in yield as that kept weed free for entire crop period. The annual yield loss in maize because of weed problems is estimated to be approximately 10%. A number of weed management practices can be adopted such as; Non-chemical control (manual weeding, mulching) and chemical control. Non-chemical weed control measures involve physical or cultural methods, such as manual removal of weeds from the maize fields. In cultural method, two hoeings 15–30 days after sowing is recommended. Mulching is practice of keeping crop residues or plastic sheets on the soil surface within the crop rows to regulate temperature, conserve water as well weed control in field crops. Chemical control; sometimes due to scarce availability of farm labour, the only effective way to control weeds is the use of herbicides. The herbicide should be applied uniformly at recommended rates to minimize residual toxicity to crops sown. Harvesting technology (50.5%); Harvesting when maize is to be consumed fresh, should be conducted when the silk has turned brown (50–70 days after planting). But when grain is needed, harvest as soon as the grain is dry enough (80– 110 days after planting) depending on the variety. During harvest, the cobs can be broken by hand from the plant or the whole plant can be cut with a cutlass. Where the entire plants are harvested, they are often stacked in the field to allow the grain to dry further. In the humid zones, the crop can be dried in a traditional ventilated granary. For use as grain, cobs should be harvested when grains are at about 20% moisture. Whereas to consume as sweet corn, harvesting should be done when tassel starts turning brown and swelling of cob initiates. Other recommended production technologies include; Fertilizer application and management (48.5%); for high yield, adequate and balanced nutrition is important in maize. Ensure proper thinning of the plants to recommended stand density then conduct weeding before fertilizer application. The following fertilizer nutrients are recommended per hectare for maize in the savannas; 100 kg N, 50 kg of single super phosphate (SUPA), and 50 kg of muriate of potash (K20). This recommended fertilizer rate should be applied in two split applications. The first dose (that is 50:50:50) should be applied at planting or within the first week of planting using about 6 bags of NPK 15-15-15. The second dose of N (50 kg, about 2 bags of urea) should be applied between 4 and 5 weeks after planting in the Southern and Northern Guinea savanna zones, but between 3 and 4 weeks after planting for extra-early varieties in the Sudan savanna. All fertilizers should be buried during application. Ensure that the second weeding has been conducted before the second fertilizer dose is applied. Note that delay in the application of the first dose of fertilizer beyond week 1 after planting will drastically reduce the grain yield of early and extra-early varieties. Also, the second dose should not be delayed beyond 4 weeks after planting. Fertilizer should be applied in small quantities of with NPK 1 week after planting. Urea should be applied at 4 weeks after planting. The fertilizer should be poured into a hole made with a stick at a distance of about 5–8 cm away from the maize plant and below the soil surface. Do not leave applied fertilizers exposed on the soil surface. Always cover applied fertilizer with soil. Among the cereal crops, maize in general and specifically hybrids are very responsive to nutrients applied through organic or inorganic means. The rate of application depends on soil nutrient status and cropping system. For realizing required yield, the dose of applied fertilizer should be on par with the soil supplying capacity and crop demand. Also it is reported that the response of maize crop to organic manures is remarkable and a very important option in maize based systems. Integrated fertilizer management may include the following techniques; apply 10–15 t/ha of good quality farmyard manure per hectare to the maize crop; green manure the field, i.e., old green manure crop should be buried and allowed to decompose for about 10 days before sowing of maize; paddy straw compost at 450 kg/ha along with recommended dose of fertilizers can be an alternate to farm yard manure; as a general recommendation, one could apply 120 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare for hybrids and 80 kg N, 30 kg P_2O_5 and 20 kg K_2O per hectare for composites, pest management (42.6%); Effective pest management includes integrated use of all possible alternates that can be physical, cultural, biological, mechanical or chemical for controlling pests. Cultural control (such as; deep summer plowing helps in destroying resting stage of pests, inter-cropping with legume reduces borer incidence, use of well decomposed farm yard manure and balanced use of fertilizers reduces termite attack). Biological control through use of good quality planting material from reliable source. Mechanical control by cutting and destroying infected plants which ceases further spread. Use of pheromone traps. Set up of light traps. Chemical control: use of synthetic chemicals for the control of insect-pest and diseases, postharvest processing techniques (40.6%); maize shelling can be done by any one of the following methods; Hand shelling• Use of internally ribbed tubes, beating cobs with a stick.• Using a single intake disc (hand-operated).• Using double intake disc (maybe hand/pedal/engine- operated). The method to use is determined mainly by output, although engine- operated multi-crop threshers used on a contract basis are gradually becoming popular. Grain cleaning. This can be done using the wind for winnowing or with screens of proper size. Maize drying is a vital operation which involves removal of moisture from the cobs/grains. It is carried out because high moisture grain will deteriorate rapidly due to grain respiration and heating, germination of grains, mold (fungal) growth and subsequent incidence of mycotoxins (e.g. aflatoxin) and increase insect multiplication and damage. The optimum moisture content of maize should be 14% or less. Types of drying; Sun drying: it is a popular method of drying grain where spread grain is exposed to direct sunlight until the desired grain moisture content is achieved. It is low energy cost; Smoking: The insect infestation is reduced when hung above the fire as the heat reduces the moisture content and the chemicals in smoke deters insect from laying eggs; Air drying: The maize cobs are hung along the roof of the house to expose it to air and hence the moisture content is minimized. Storage methods (34.7%); the walls and floor of the rumbu or granary must be cleaned thoroughly. Phostoxin tablets or pellets may be used to store more maize in an airtight container or large storage in sacks. Large-scale storage in bags such as pyramids will require a complete cover with tarpaulin after application with 4–6 tablets or pellets per ton, (wrapped in newspaper) in some of the bags. The tablets or pellets could also be enclosed in perforated envelopes instead of newspapers. Such storage should not be disturbed frequently for greater effectiveness. For fumigants to be effective, they must be applied where there is air-tight storage condition in sacks, containers or buildings. For bagged produce, the rate is 1-2 tablets per 100 kg grain sack. The tablet is wrapped in small tissue paper and placed in the middle of the sack. Also, grains must be properly dried; below 12 percent moisture level before storage to avoid mold. Clean granaries and stores before filling with new grains. A farmer can buy these chemicals from reputable agro chemicals dealers or retailers. Whenever phostoxin tablets are used, ensure the store is airtight to avoid the escape of fumes that are poisonous to human beings and animals when inhaled. For non-chemical storage, farmers are advised to store maize in Purdue Improved Crop Storage (PICS) bags. Water management (27.7%); Water requirement of the maize crop varies from 400 to 600 mm. Excess or shortage of moisture can have harmful impact on the crop growth. Proper drainage of standing water and meeting the crop needs at critical stages play a pivotal role in better crop performance. Disease control (14.9%); dressing the seeds prior to planting easily controls most of the diseases (whether soil-or seed-borne). A few pests such as stem borers, and grass hoppers occur occasionally and rarely present any serious challenge. These production technologies adopted significantly affected maize yield and the level of farm productivity. However, the level of adoption of these production technologies among maize farmers was relatively low in the study area (Maiangwa, 2008; Knowler and Bradshaw, 2007).

3.2 Index of Adoption of Production Technology

Table 3: Distribution based on the Index of adoption of Production Technology

Adoption index	Frequency	Percentage (%)
Low adoption index	62	61.4
High adoption index	39	38.6

Source: Field survey, 2020.

The result in Table 3 reveals that most (61.4%) of the farmers have low adoption index of ≤0.39; while, 38.6% have high adoption index of ≥0.4. Therefore, it is evident that several technologies for improved maize production are available in the area. However, the index of adoption of these technologies is very low and not satisfactory. This trend is responsible for the existing low farm productivity for this crop in the area as observed in previous studies (Bonabana- Wabbi, 2002; Maiangwa, 2008). It is well known that in sub-Saharan Africa low agricultural productivity by small scale farmers have been attributed to poor adoption of improved agricultural technologies. Therefore, identification of factors hindering adoption/uptake of improved agricultural technologies has been an important research agenda in the area (Bonabana- Wabbi, 2002).

3.3 Correlation of Multivariate Factors (Output, Adoption Cost and Adoption index)

Table 4: Correlation Coefficient Matrix

Factors	Farm Output (z)	Adoption cost (x)	Adoption index (y)
Farm Output (z)	1.00		
Adoption Cost (x)	-0.65*	1.00	
Adoption index (y)	0.52*	-0.58*	1.00

Source: Field Survey, 2020; *Correlation coefficient (r) is significant at 5% level (2-tailed).

The result of the correlation analysis in Table 4 revealed that at 5% level of significance, the null hypothesis that there is no significant relationship between Output, Adoption Cost and Adoption index is rejected. This suggests a significant linear relationship between the multivariate factors exists in the study area. The estimated correlation coefficient between x and z (r_{xz}) was -0.65 which suggests a moderate and negative linear relationship between the factors. This implies that as adoption cost increases the tendency of adoption of production practices that boost farm output declines. The estimated correlation coefficient between y and z (r_{yz}) was 0.52 which suggests a strong and positive linear relationship between the factors. This implies that as more production technologies are adopted the level of farm productivity tends to increase. The estimated correlation coefficient between x and y (r_{xy}) was -0.58, which suggests a moderate and negative linear relationship between the factors. This implies that as adoption cost increases the index of adoption of production technologies among the maize farmer's declines. The implication of these findings is that adoption of production technologies tends to increase the level of farm productivity in the study area and hence improve agricultural sustainability. Furthermore, the cost of production practices determines farm level adoption. Thus, this result corroborates with the findings of Yasin (2003) who also examined the relationships between similar multivariate factors among farmers in the adoption of production practices.

4.0 Conclusion and Recommendations

This study analyzed the correlation between adoption index of production technology, adoption cost and farm output among maize farmers in Toro local Government Area of Bauchi State, Nigeria. Furthermore, there were a variety of maize production technologies in the study area; however adoption of these technologies was relatively low. Also, a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index) exists in the study area. Based on the findings of this study, the following recommendations are made:

1. Formulation and implementation of policies that will subsidize the cost of maize production technologies.
2. Formulation and implementation of policies that will improve farmers access to production technologies.
3. Formulation and implementation of policies that will improve farmers' access to agricultural credit, this will enable them adopt more options of production technologies.
4. Improving farmers' access to extension services to improve their access to technology and mitigate any challenges encountered in the adoption of production technologies.
5. Mechanized agriculture was found to be poorly adopted and practiced in the study area. This might be attributed to low capital and small scale production in the study area. To this, the government should provide more mechanized agricultural machineries at a

subsidized and a cheap rate to maize farmers in the study area so asto boost their productivity.

6. Formulation and implementation of policies that will ameliorate labour supply cost and indiscriminate land fragmentation for maize production in the study area.

References

Abebaw D. & Abelay, K (2001). Factors Influencing Adoption of High Yielding Maize Varieties in South Eastern Ethiopia: An application of quarterly Journal of International Agriculture.

Abdulrahaman A. A, & Kolawole O.M (2006). Traditional preparations and uses of maize in Nigeria. Alama J.F (2001).Economic analysis of maize production using two technologies in Kaduna State, Journal of Arid Agriculture. 11:125-129

Ajayi, P.Z, Odoul, O.C and Agunya P.A (2008). Socio-economic factors influencing adoption of improved fallow practices among small holder farms in Western Tanzania, International NGOJ.

Ali-Olubwanda A.M, Odero-Wanga D, Kathuri N.J &Shigova W.A (2010). Adoption of improved maize production practices among small scale farmers in agricultural reform era: The case of western province of Kenya. Journal of International Agricultural & Extension Education 17(1):21-30

Bawa D.B &Ani A.O (2014).Analysis of adoption of improved maize production technology among farmers in Southern Borno, Nigeria. Research on Humanities and Social Science. 4(255):43-54 Benicini M.C (1991). Post-harvest and processing technology. Food & Agriculture Organization of the United Nations.

Bonabana-Wabbi, J. (2002). Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM) In Kumi District, Eastern Uganda. Msc(Agricultural and Applied Economics) Thesis Submitted to The Faculty of The Virginia Polytechnic Institute and State University. 146pp

Frova C, Krajewski P, Fonzo ND, Villa M, & Sari Gorla M (1999).Genetic analysis of drought tolerance maize by molecular markers. Theory and Applied Genetics 99:280-288.

Gujarat D.N (2004), Basic econometrics, fourth edition. Tata McGraw-Hill Publishing Company Limited, New Delhi, India Idrisa Y.L & Ogunbamer B.O (2008). Farmers' assessment of the Unified Agricultural Extension. 11:106-114

Idrisa Y.L, Shehu H, and Ngandu M.B (2012).Effect of adoption of improved maize seed on household food security in Gwoza EGA of Borno State, Nigeria. Global Journal.Vol 12, ISSN 5 version

Iken J.E and Amusa N.A (2004), Maize research and production in Nigeria. *African Journal Of Biotechnology.*

International Institute of Tropical Agriculture (IITA, 2001), Annual Report on Maize.

Knowler D and Bradshaw B (2007).Farmers adoption of conservation agriculture, a review and synthesis of recent research, food policy 52:25-48

Komolafe S.E, Adeseji G.B &Ajibola B.O (2010). Determination of adoption of improved crop practices among women farmers in Ekiti East LGA of Ekiti State, Nigeria. Journal of Agricultural Research 5(2):22-3E

Maiangwa N.G (2008). Adoption of mixed cropping by fanners in the North Western Zone of Nigeria, Global Journal of Agricultural Research

Manyong V.M, Makinde K.O & Coulibaly 0 (2005). Economic grains from maize research in West and Central Africa, an overview in B. Badu-Akraku, M. Oudraeogo collaborative research network, IITApp 66-780 Matata

National Bureau of Statistics, (NBS 2006). Annual abstracts of statistics, Federal Republic of Nigeria

National Agricultural Extension Research & Liaison Services (NAERLS) and Federal Department of Agricultural Extension (FDAE,2014). Agricultural Performance Survey of 2014.Wet season in Nigeria, Executive summary. Pp 23

Ouma J.O, Murithi M.F, Mwangi W, Macharia H.G &Gronte H.D (2002).Adoption of maize seed and fertilizer technologies in Embu district, Kenya Mexico Rogers E.M (2003).Diffusion of innovation, fifth edition, New York, the free press.

Philips, D., M. Masangwa and B. Philip, 2000. Adoption of maize and related technologies in the north-west Zone of Nigeria. Moor J. Agric. Res., 1: 98-105.

Yasin, G., Aslam, M., Parvez, L. and Naz, S. (2003). Socioeconomic Correlates of Pesticide Usage: The Case of Citrus Farmers. Journal of Research (Science), Bahauddinzakariya University, Multan, Pakistan. Vol.14, No. 1, June, Pp. 43-48.