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Application of Monte Carlo Simulation Techniques to Measure the Impact of Distance Function on adoption of Yam techniques by farmers in Abia State, Nigeria

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ABSTRACT: The work examined the impact of distance function on the adoption of yam technologies by farmers in Abia state. To do this, copies of questionnaires were administered for which representers were also retrieved. The Monte Carlo Simulation Techniques were used to measure the intensity of distance function over other impediments like cultural boomers and physiographic impediments. The Natural Root Crop Research Institute Umudike was identified as the mean Agricultural technologies emerge and distributed to farmers in the state. More than 43% of the respondents identified distance farmer as a major correspondent to the adoption of yam technologies in the state. The mean values obtained from the growth probability matrix and final simulated which are 0.0733 and 6.50 were both higher than similar values of other factors. In testing of the hypothesis the alternative hypothesis, which stated factor that distance function was the major factor hindering adoption of yam technologies were adopted. This is because, calculated value of 2.13. Among other values, it was recommended that enhancing the activities of the Agric Extension officers will help to improve the rate of adoption of yam technologies.

KEYWORDS: Abia State, Monte Carlo Simulation Techniques, Umudike, Alternative hypothesis, Agric Extension Officers, Natural Root Crop Research Institute.

I.INTRODUCTION

Hunger and starvation has over the years been a recurring phenomenon for the less development nations, especially Sudan, Ethiopia, Uganda, Bangladesh, Somali, Haiti and Bolivia. Food crisis have attracted quick responses from governments, international Organizations, NGOs and religious bodies. FAO estimates that UN needs over 50 billion dollar every year to address the food problem in the world. Yet less than 1 billion dollars is received in donations and grants (FAO, 2009). It is against this background that several agricultural technologies have been introduced with the intent of improving food production especially for the most vulnerable people. The idea is to make them independent and less reliant on the food products given to them every year by donor agencies. Nevertheless, problems like; land conflicts and ownership, increasing costs of inputs, pests and diseases, lack of education economic down turn, wars and conflicts, political instability and corruption have contributed immensely in frustrating and limiting the expected gains from several technologies made available to the farmers. Furthermore, the small householder farmers one constrained by many problems, including poor access to modern inputs and credits poor infrastructure, inadequate access to marked land and environmental degradation, inadequate research and extension services(Asumugha and Ekwe, 2011). Hence the need for improved yam seedlings to increase food production and at the same time generate income for the farmers, administrative inadequacies and physiographic impediments have galvanized themselves to serve as major impediments to the spread, adoption and implementation of the yam technologies in the farming zones of Abia state. Beyond all the issues outlined, distance function plays a major role and it constitutes the focus of this work.

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A. THEORETICAL FRAMEWORK

Monte Carlo simulation technique is defined as a game of dice in which the yaming table represents a part of the earth's surface (Haggerstand, 1965). The pieces represent individuals living in the area and the rules of the game constitute the particular factor which we want to study (Ackoff, 1962) suggested four main uses of Monte Carlo simulation techniques;

i) It can be used to determine the values of control variables
ii) To test the effects of changes in probability values and parameters.
iii) It can help to trace the trajectory of dynamic systems, while the parameters could be entity estimated and sensitivity analysis carried out.
iv) It can be used to experiment with different inputs and parameters in addition to the examination of the effects of certain constraints.

Monte Carlo simulation has been applied in several fields of geographic research; Ayeni (1979), Alozie(2001), and Madu, (2014)

Hypothesis; Adoption of yam technologies is not significantly hampered by distance bias than social economic, administration and physiographic factors.

B. STUDY AREA

Abia State is one of the states in south eastern Nigeria. Abia State occupies an area of about 6320 square kilometres. Abia State has a variety of land forms despise the fact that it is dominated by flat and low-lying land generally rising from less than 120m to 180m above sea level (Abia State, 2009). The low-lying plain is the inland extension of the coastal plain from the Bight of Benin. The central part of the state is characterized by undulating land with many hills. The highland areas are a part of the Enugu-Nsukka Okigwe Questa, From Okigwe (Imo state), and the escarpment extends in a west east direction and on getting to Afikpo (Ebonyi State) rears south east wards to Arochukwu. Nine geological formations exist in Abia State. They include; the benin formation, Bende-Ameki group, Nkporo shale group, Nuskka formation, Igali sandstones, Eze-Azu shale group and Asu River group. There are two seasons in the year namely; the rainy season and dry season. The rainy season starts in March and ends in October with break in August, usually referred to as the little dry season. Dry season which lasts four months begins in November. Heavy thunderstorm is characteristic of the onset of the rainy season. Rainfall decreases from 2200mm in the south to 1900mm in the north. The hottest months are January to March when the mean temperature is above 27oc. Relative humidity is usually high throughout the year, reaching a maximum during the rainy when values above 90% are recorded. Abia State is mainly an agricultural state located in the rain forest belt and woods of economic values in all the three agro-ecological zones.

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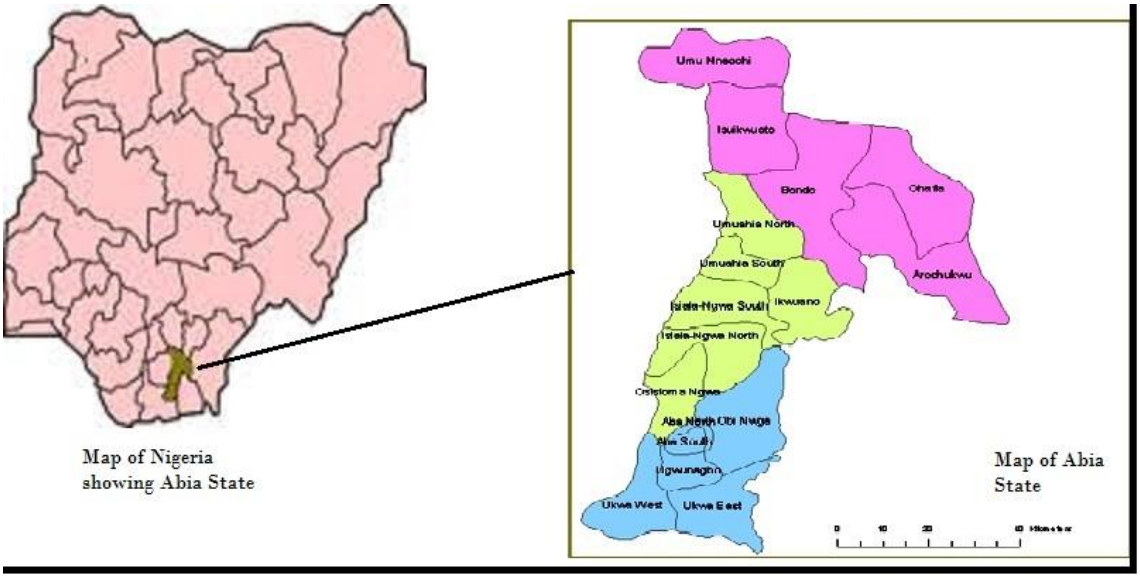

Study Map.

II. METHODOLOGY

The study locations were systematically selected. This was necessary to achieve spatiality in analysis in analysis and conclusion for this purpose; two local government areas were randomly selected from each of the three senatorial zones in the state (Abia North, Abia Central and Abia South). The local government areas selected include; Ikwuano-umuahia, Isiala Ngwa; Isuikwuato; Ohafia, ukwa East and Osisioma. The sample size for the work was selected by applying the stratified system, each location serves as a stratum giving rise to a matrix or strata. In each of the location, random sampling technique was adopted to select the actual respondents needed to be interviewed. Based on this, 200 respondents were selected from each stratum.

Table 1: Distribution of Respondents

Location	Number of Respondents	Pop size of LGAs, (NPC, 2012)
Isuikwuato	200	138,381
Ohafia	200	293,716
Ikwuano	200	164,652
Isiala Ngwa North	200	183,617
Osisioma	200	263,478
Ukwa East	200	69,418
Total	1200	1,113,312

Source (1) Pop size projected from 2006 lease year at 3% incremental rate.

Each location relieved equal number of respondents irrespective of their population sizes. This was necessary in order to have an equal assessment of the impact of distance function and other usual impede the rate of assimilation and adoption of yam technologies. In addition, the total number of farmers in the state was difficult to ascertain. A structured questionnaire was administered on the respondents for which 1081 copies representing 90.08% were retrieved.

Table 2: General Response Intensity

Agricultural Location	Number of questionnaire distributed	Number of questionnaire returned	No of questionnaire not returned
Isuikwuato	200	180	20
Ohafia	200	185	15

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Ikwuano	200	178	22
Isiala Ngwa North	200	172	28
Osisioma	200	180	20
Ukwu east	200	186	14
Total	1200	1081	119
Percentage Rating	100	90.08	9.92

As presented in table 2, return rate was 90.08%, meaning that distribution system adopted was production. They` were questions administered orally by 12 research assistants that participated in the questionnaire distribution.

A. Analytical Procedure

The formula for monte carlo simulation technique is given as $dx=d_o \exp(-bx)$….(1)
Where dx is the population density at distance x from the point of mean information field (MIF). While b is the density gradient. In partial terms, the formula arises from the point close matrix (observed). If we then add all the elements of the points by the total, we arrive at a growth probability matrix. This is given as
$S= \sum_{i=1}^{n} \sum_{i=1}^{m} S(1)$ ----------(2)
And = Pij = si/s i=1 ----------n,j=i---m(3)
Where therefore note that $\sum_{i=1}^{n} \sum_{i=1}^{m} Pi =1.0$ ----------(4)
It is usual to convert the probability surface above into random number fields for the allocation process. This is done again in a two stage process that involves neglecting the denial signs and then making successive cumulating for row beginning with the first row and moving from left to right.
By the cell elements of our probability matrix after we have neglected the decimal points, the denoted by riji, then each element of the random number matrix (qi) is given by

$$qi = \sum_{i=1}^{n} \sum_{i=1}^{m} rij \text{ ----------(5)}$$

Thus for the first cell of the first row q^{ij}- r^{ij} while for the fifth cell of the second row is

$$q^{25} = \sum_{i=1}^{n} \sum_{i=1}^{m} + \sum_{i=1}^{n} r2j \text{ ----------(6)}$$

-
Thus the grand summation represented by the fifth of the third row is 1999. This is as expected, since our table is simply a two dimensional cumulative table. The figures in each cell therefore are upward limiting number for the conversion of the conversion of the table into a random number field (Ayeni, 1979). Afterward, the random number field is converted into a field that specifies the range of values of the numbers to be used in allocating factors of growth. This is done by specifying the lowest and highest values in each cell. For instance, the first cell would have the values 000- to m….9999.
Allocation procedure to identifying the number of times each random range appeared in a computer generated random numbers of random number in a statistical table done. The result is referred to as tally table of random number allocated. At the end, final outcome of tallied results or expected (E) is constructed. In this work the expected results (E) was subjected to testing using the product moment correction (PMC).

III. Results and Discussions

Table3. Major impediments to the adoption of yam technologies by farmers in the area.

Location	Cultural Barriers	Economic cost	Distance Function	Administrative inadequacies	Physiographic Impediments	Total
Isuikwuato	28	30	80	22	20	180
Ohafia	22	36	86	24	17	185
Ikwuano	26	31	78	17	26	178
Isiala Ngwa North	27	30	68	22	25	172
Osisioma	26	22	85	26	21	180
Ukwa East	27	29	78	28	24	186
Total	156	178	475	139	133	1081
Percentage Rating	14.43	16.47	43.94	12.86	12.30	100

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In table 3 more than 43% of the farmers argued that distance was a major bias affecting the rate adoption of yam technologies. Others include; economic cost, 16.47%; social farmers, 14.43%; administrative inadequacies, 12.86% and physiographic impediments 12.30%. the response rate for distance function is significant. The implication is that farmers who are residing at Ohafia, Osisioma, Isuikwuato and Ukwa east are most likely to suffer problems of distance functional disequilibrium. Thus, the yam seedlings distributed will likely suffer loss of fertility value excessive water loss, breakage and reduction of spillage ratio value.

A. Procedures in using Monte Carlo Technique

Given the theoretical bases of monte carlo simulation technique, procedures for its use include;

1. The formulation of a test of possible hypothesis on the factor governing the system.
2. The construction of a matrix of probability from the theoretical bases of the system of interest.
3. The allocation procedure using both the probabilities matrix and a random number table.

B. Generation of Assumptions

1) That distance function is a major factor inhibiting the adoption of yam technologies
2) That cultural barriers are notable in inhibiting the adoption of yam technologies by barriers in the area.
3) Adoption of yam technologies are hampered by administrative inadequacies.
4) Adoptions of yam technologies are hampered by physiographic factors.
5) The adoptions of yam technologies are hampered by economic costs.

To calculate for the expected (simulated result which is in line with the generated assumptions, data presented in table 3 were arranged to form the point score matrix, which is also given as the observed.

Table 4

Stage1: point score matrix

	Isuikwuato 1	Ohafia 2	Ikwuano 3	Isialangwa North 4	Osisioma 5	Ukwa east 6	Total	Percentage Rating
A Cultural Barrirers	28	22	26	27	26	27	156	14.43
B Economic cost	30	36	31	30	22	29	175	16.47
C Distance Function	80	86	78	68	85	78	475	43.94
D Administrative inadequacies	22	24	17	22	26	28	139	12.85
E Physiographic Impediments	20	17	26	25	21	24	133	12.30
Total	180	185	179	172	180	186	1081	100

Table 5

Stage II: Growth Probability Matrix (A)

	1	2	3	4	5	6
A	28/1081	22/1081	26/1081	27/1081	26/1081	27/1081
B	30/1081	36/1081	31/1081	30/1081	22/1081	29/1081
C	80/1081	86/1081	78/1081	68/1081	85/1081	78/1081
D	22/1081	24/1081	17/1081	22/1081	26/1081	28/1081
E	20/1081	17/1081	26/1081	25/1081	21/1081	24/1081

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Table 6
Stage III Growth Probability Matrix (B)

	1	2	3	4	5	6	Total	Mean Value
A	0.0259	0.0204	0.0241	0.0249	0.0241	0.0249	0.1443	0.0241
B	0.0278	0.0333	0.0287	0.0278	0.0204	0.0268	0.164	0.0273
C	0.0740	0.0796	0.0722	0.0629	0.0786	0.0722	0.4395	0.0733
D	0.0204	0.0222	0.0157	0.0203	0.0241	0.0259	0.1286	0.0214
E	0.0185	0.0157	0.0241	0.0231	0.0194	0.0222	0.123	0.0205

Table 7:
Stage IV: Removing the Decimal

	1	2	3	4	5	6
A	259	+204	+241	+249	+241	+249
B	+278	+333	+287	+278	+204	+268
C	+740	+796	+722	+629	+789	+722
D	+204	+222	+157	+203	+241	+259
E	+185	+157	+241	+231	+194	+222

Table 8:
Stage V: Upward Limiting Number of a Random Number Field

	1	2	3	4	5	6
A	259	465	704	953	1194	1443
B	1721	2054	2341	2619	2823	3091
C	3831	4627	5249	5978	6764	7486
D	7690	7912	8069	8272	8513	8772
E	8957	9114	9355	9586	9780	9999

Table 9:
Stage VI The Random Number (RNF)

	1	2	3	4	5	6
A	0000-0259	0260-0463	0464-0704	0705-0953	0954-1194	1195-1443
B	1444-1721	1722-2054	2055-2341	2342-2619	2620-2823	2824-3091
C	3091-3831	3832-4627	4628-5349	5350-5978	5979-6764	6765-7486
D	7487-7690	7691-7912	7913-8069	8070-8272	8273-8513	8514-8772
E	8773-8957	8958-9114	9115-9355	9356-9586	9587-9780	9781-9999

Table 10:
Stage VII: Tally Table of Random Number Allocated

	1	2	3	4	5	6
A	II	III	II	I	IIII	II
B	IIIII I	IIII	IIIII I	I IIIII	I	II
C	IIIII I	IIIII I	IIIII IIIII	IIIII I	IIIII	IIIII I
D	IIII	---	---	---	II	IIIII
E	II	II	III	IIIII	I	II

Table 11
Stage VIII Final Simulation Result (E)

	1	2	3	4	5	6	Total	Mean Value
A	1	3	2	1	40	2	13	2.17
B	6	4	1	4	2	2	19	3.17

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C	6	6	10	6	5	6	39	6.5
D	4	0	0	0	2	5	11	1.83
E	2	2	3	5	1	2	15	2.5

A – Cultural Barriers
B – Economic cost
C – Distance Function
D – Administration Inadequacies
E – Physiographic Impediments

Test for the hypothesis, results in tables 4 (point score matrix) and table II (final simulated result (E)) were pulled together in table 12 and subsequently tested with product moment correlation (Pm). After which both the tcal and tabulated values were obtained.

Table 12: Testing simulated Result against the point score using P.M.C

Point score X	Simulated Y	X^2	XY	Y^2
28	1	784	28	1
22	3	484	66	9
26	2	676	52	4
27	1	729	27	1
26	4	676	96	16
27	2	729	54	4
30	6	900	180	36
36	4	1296	144	16
31	1	961	31	1
30	4	900	120	9
22	2	484	44	4
29	2	841	58	4
80	6	6400	480	36
86	6	7396	516	36
78	10	6084	780	100
68	6	7396	516	36
85	5	7225	425	25
78	6	6084	468	36
22	4	484	88	16
24	0	576	0	0
17	0	289	0	0
22	0	484	0	0
26	2	676	52	4
28	5	784	140	25
20	2	400	40	4
17	2	289	34	4
26	3	676	78	9
25	5	625	125	25
21	1	441	21	1
24	2	576	48	4
E		53573	4603	473

Co-efficient of r Value = 0.9144
t calculated value = 4.5178
t tabulated value 2.13 @ 95% confidence level

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Ho: Adoption of yam technologies is not significantly distance bias than social, economic, administrative and physiographic factors

H1: Adoption of yam technologies is significantly hampered by distances bias than social, economic, administrative and physiographic factors

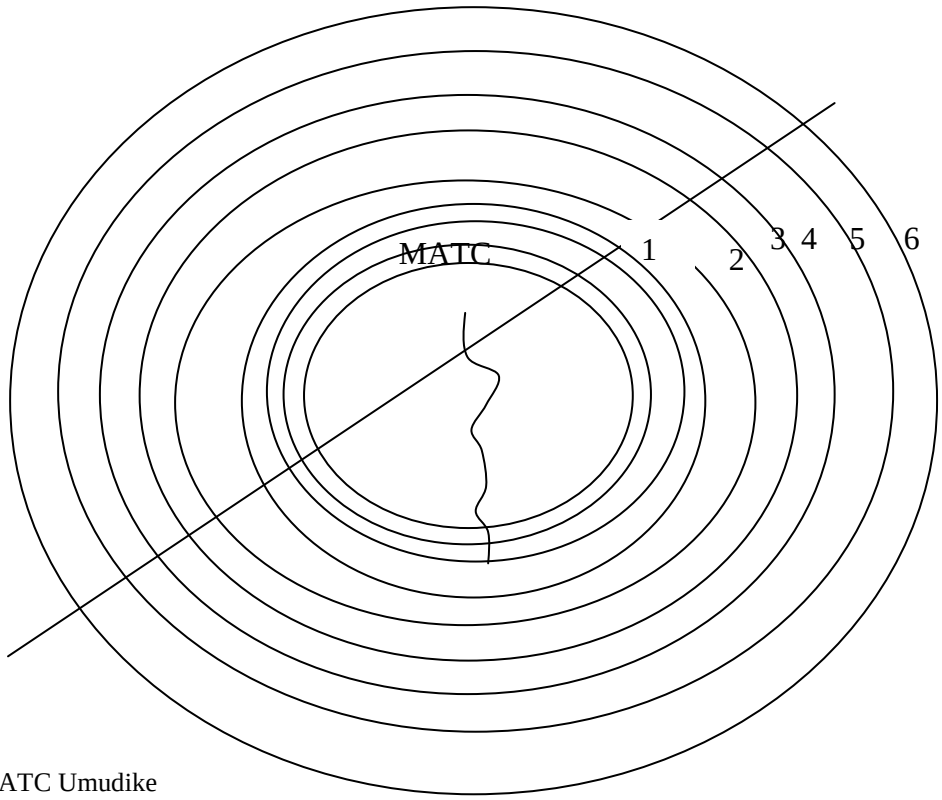
Decision Rule

The 'r' value is 0.9144. This signifies a positive correction since it is > 0.5. To accept Ho and reject H1, the t-cal value must be > t-tab. Incidentally, from the result shown in table 12, t cal is 4.5178, while ttab is 2.13. We therefore accept H1 which states that adoption of yam technologies is significantly tempered by distances barrier than social, economic, administrative and physiographic factors

General response intensity is high, 90.08%. Respondents were very responsive strengthened our investigation and adoption of Monte Carlo simulation technique in measuring the impact of distance on the adoption of yam technologies by farmers in Abia State Nigeria. In table 3, major impediments to the adoption of yam technologies by farmers in the state were outlined by the respondents. Despite other factors like; cultural barriers, 14.43%; economic cost, 16.47%; administrative adequacies, 12.86%, physiographic impediments, 12.30%, distance function recorded the highest response of 43.94%. Farmers who reside in Osisioma, Ukwa east, Isuikwuato and Ohafia are very likely to be affected grossly by distance. This is because the centre of innovation, otherwise referred to as the Mean Agricultural Technologies Centre (MATC) is the National Root Crop Research Institute, Umudike Umuahia (NRCRI) were in yam technologies emerge to serve as a centre of innovation spread to the surrounding agricultural zones in the state.

In 1988, the National Roots crop Research Institue, Umudike, through the collaboration effort of IITA Ibadan developed seven hybrid yam varieties. There include; yam minisett, yam minituber, modified yam D rotun data, D alata for dry season production and seed yam minisett technology using 30-45g sett size(Ikengu and Igbokwe, 2002) later in 2008, technologies were developed. Udalor and Ezulike (2009) identified as; TDR 89/02185; TDR89/02677; TDR89/01438 and TDR95/01924. Others include; TDR89/02461; TDR89/01213 and TDR89/02685.

These technologies were passed on to the farmers by extension officiers. To illustrate this further, fig1 shows a concentric cycle of dominance of agricultural technologies signifying intensities across the geograghic space of Abia state. The diagram shows very clearly that intensities diminish with increasing distance.



MATC Umudike

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LEGEND

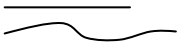
Circle	Range	
		Road River system
1	10Km radius	Ikwuano Umuahia
2	30Km radius	Isiala Ngwa North
3	50Km radius	Isuikwuato
4	60Km radius	Osisioma
5	70Km radius	Ohafia
6	80Km radius	Ukwu East

Fig1: Concentric Circles Representing Spread of yam Technology.

In Tables 6 mean values were highest for distance function at recorded 0.0733 awhile the mean simulated result of 6.50 for distance function was also higher when compared with others, which are as follows; cultural barriers 2.17; economic cost, 3.17, administrative inadequacies, 1.83 and physiographic impediments 2.5. in addition, the alternate hypothesis was accepted since the calculated value of 4.5178 was greater than tabulated value of 0.91444. it is important to note therefore, that distance function is a major impediment so the spread, assimilation and adoption of yam technologies across the geographic spread of Abia State.

IV. RECOMMENDATIONS

Geographic space in the sense of this work is absolute destructive and definite, but it can done in a way that farmers are able to receive information of on these technologies, without content, quality, and emphasis lost over time and space. The agric extension agents have the mandate to disseminate general information on farming methodologies, seedling constituents and adaptabilities, seedling soil requirements, biotechnology, pests, diseases and weed management, fruiting and harvesting technology and land management. It would then be proper to enhance their activities. Aderibigbe (2009) and Madu (2014) suggested that proper information dissemination increases the propensity of adoption of the yam technologies by a reasonable number of farmers. Other issues of cultural farmers, physiographic impediments and economic costs also need to be addressed.

Conclusion

We conclude that adoption of yam technologies from the Mean Agricultural Technologies Centre (MATC) which in this case is the National Root Crop Research Institute, Umuahia is still very slow. It has been hundred more by distance bias, and other issues like physiographic impediment. Nevertheless adoption rate can also be improved if the activities of the extension workers are enhanced.

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