WHAT IMPACT DOES THE ADOPTION OF DROUGHT-TOLERANT MAIZE FOR AFRICA HAVE ON THE YIELD AND POVERTY STATUS OF FARMERS IN THE ARID REGION OF NIGERIA?

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Abstract: Maize production in Nigeria has not been able to meet the needs of people owing to drought, low productivity and lack of access to improved varieties by the farmers. Increased agricultural yield is a potential means for increasing household income, which tends to lower the poverty status of small-holder farmers. This study assessed the impact of Drought-Tolerant Maize for Africa (DTMA) on the yield and poverty status of farmers in the northwestern region of Nigeria. The study used the dataset from Adoption of DTMA Survey by the International Institute of Tropical Agriculture (IITA), Ibadan, with 293 respondents from northwestern Nigeria (90 adopters and 203 non-adopters of DTMA). Data were analysed using descriptive statistics, binary regression and propensity score matching methods. Results showed that small-holder farmers were more likely to adopt DTMA than bigger farms. Adopters had an increase in DTMA yield of 9,262.77kg/ha while the counterfactual non-adopters had an increase of 3,807.74kg/ha. The adoption of DTMA reduced the probability of being poor by 60 percent for the treatment group while poverty incidence was reduced by 35% among the non-adopters. The general conclusion is that DTMA adoption program improved maize yield and reduced poverty incidence among rural households.

Key words: DTMA, poverty, Sudan savannah, propensity score matching, northwestern Nigeria.

Introduction

Maize is the major staple food and feed in sub-Saharan Africa (Elbehri et al., 2013; Macauley, 2015). However, drought is a major challenge to maize production in northern Nigeria given the increasing evidence of climate change (Ogunlade et al., 2010). Despite the great potential of Nigeria in cereal production, the frequent occurrence of drought (more moisture loss from soil surface and fewer precipitation water supplies to soil) occasioned by erratic rainfall distribution

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and/or cessation of rain during the growing season is the greatest hindrance to increased production and productivity (Khand et al., 2017). Drought reduces crop yield (Ray et al., 2018), which discourages farmers. Until recently, low productivity of maize could be attributed to the continuous use of traditional varieties which are characterized by low yield and a long maturing period hence easily susceptible to diseases and drought (Awotide et al., 2012). However, increased agricultural productivity has been identified as a potential means for improving the availability of food for household members as well as increasing income and consequently lowering the poverty status among small-holder farmers (Gordon, 2000; Manda et al., 2015).

The average yield of maize in Nigeria declined from < 1.7 metric tonnes/ha in 2016 to 1.5 metric tonnes/ha in 2017 below Africa (2.17 metric tonnes/ha) and the global averages (5.7 metric tonnes/ha) in 2017 (FAOSTAT). This may be attributed to the fact that maize production is largely rain-fed in Nigeria, characterized by irregular rainfall that tends to result in drought. Furthermore, maize production has not been able to fill the demand and supply gap owing to the level of adoption of improved varieties by the farmers despite the introduction of improved varieties (Elbehri et al., 2013). However, improved maize seeds that will only improve yield without drought resistance may not yield an expected outcome under rain-fed agricultural production, especially in the arid regions. Thus, owing to the increasing demand as a result of population increase, there is a need to increase the production of maize to meet the soaring demand of the growing population through the introduction of improved maize varieties. Hence, the introduction of high-yielding varieties which mature quickly and are less susceptible to diseases will increase maize yield. The Drought Tolerant Maize for Africa (DTMA) which was developed with a unique feature of being drought resistant was funded by the Bill and Melinda Gates Foundation to tackle the menace of low productivity and reduce the poverty level amidst small-holder farmers (Awotide et al., 2016). However, the aim of introducing or convincing the farmers to adopt agricultural technology has not been achieved due to their continuous use of traditional varieties. Adoption of DTMA by farmers is determined by several socioeconomic and demographic factors.

The majority of the poor in Nigeria are living in rural areas and they are mainly farmers (Obayelu and Awoyemi, 2010; NBS, 2015). Increasing technology adoption such as new agricultural practices and high-yielding varieties has the potential to contribute to economic growth and poverty reduction among the poor (Kelsey, 2011). A major way to achieve the objectives of the Sustainable Development Goals of eradicating extreme poverty and hunger is by increasing agricultural productivity through yield-increasing technologies in order to sustain food self-sufficiency (Melesse, 2015). In addition, studies have shown that a high measure of improvement can be attained if farmers are properly informed and
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aware of improved technologies that are available (Ibrahim et al., 2012). These improvements have attractive attributes such as higher yield, shorter maturing period and low susceptibility to diseases, with increased productivity and enhancement of quality of harvested crops. Increased productivity will over time increase farmers’ income from the sales of produce, thereby reducing the level of vulnerability to poverty. It can, therefore, be concluded that the uses of improved varieties are keys in the realization of increased agricultural productivity and in raising the standard of living of the farming population (Adenuga et al., 2014).

This study aims to contribute to the existing literature by providing a new perspective on the impact of drought-tolerant maize varieties on productivity and poverty status of farmers in the northwestern region of Nigeria. The specific objectives were to identify the factors influencing the adoption of DTMA and estimate the impact of adoption on the yield of maize and poverty incidence of farmers in arid northwestern Nigeria.

Material and Methods

The survey of Drought-Tolerant Maize for Africa was conducted in Nigeria from November 2014 to February 2015 by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. For the purpose of this study, data for northwestern Nigeria (NW) was extracted from the whole data set. Zamfara and Kaduna states were the selected states, which represented the northwestern region of the country in the survey. The vegetation cover for the study area is the Sudan savannah, characterized by scattered short trees, shrubs and grasses. The climate is tropical with an annual temperature of 25.2°C and about 1211mm of precipitation annually. Both states are involved in agriculture as the mainstay of the economy and produce similar crops which include cotton, groundnut, tobacco, maize, beans, guinea corn, millet, rice. These states were purposively selected due to the implementation of the DTMA project there. The data set for northwestern Nigeria comprises 293 respondents (90 adopters and 203 non-adopters of DTMA varieties). The structure of the data collection instrument suggests that key variables for the proposed study were adequately covered.

The logit regression was used to identify factors influencing the adoption of DTMA while the propensity score matching was used to assess the impact of the adoption of DTMA on the poverty status of the households. The main steps involved in the application of statistical matching to impact evaluation were: estimating the propensity score, matching the unit using the propensity score, assessing the quality of the match and estimating the impact and its standard error. The core characteristic of the matching procedure is the establishment of the conditions of a randomised experiment, in order to evaluate a causal effect as in a controlled experiment. To achieve this, we need the conditional independence
assumption, which states that technology selection is random and uncorrelated with outcomes (yield and poverty incidence) (Mendola, 2007). To examine the impact of DTMA adoption on the yield and poverty status of the farmers in the study area, kernel propensity score matching was used to check whether there was a statistical difference between the means of the matched variables and the average treatment effect. The propensity score is a probability which is the interval (0, 1) (Table 1). Therefore, the independent variables had an average effect of 32% on the probability of farmers adopting the DTMA indicating that the population had 32% chance of adopting DTMA with respect to the outcome variable (yield and poverty).

Table 1. Summary statistics of the propensity score matching.

| Variable      | Observation | Mean   | Standard deviation | Minimum | Maximum |
|---------------|-------------|--------|--------------------|---------|---------|
| Propensity score | 293         | 0.3159 | 0.2378             | 0.0047  | 0.9765  |

Source: Author’s computation (2017)

Furthermore, the common support graph gives a clearer picture of the similarities in characteristics between the treatment and control groups (adopters and non-adopters). The common support graph finds the matches from the comparison group so that the measured cofounders can be equally distributed between treatment and control groups. The graph further helps to improve the precision of estimates of treatment effects. The importance of the common support graph is to improve the quality of the match by ensuring that matches are formed only when the distribution of the density of the propensity scores overlaps adopter and non-adopter observations (Heckman et al., 1999). This test further ensures effectiveness as it gives a visual presentation of the density distribution of the treated and control cases indicating the existence of substantial overlap in the density distribution of the estimated propensity scores of the adopters and non-adopters, thereby satisfying the common support condition. Figure 1 shows the distribution of the propensity scores and the region of common support between the adopters (upper portion) and the non-adopters (lower portion). It revealed the bias in the distribution of the propensity scores between the adopters and non-adopters, and clearly suggested the significance of proper matching and the imposition of the common support condition to avoid bad matches. In addition, it is evident from this graph that there was a good match as there were no variables lying outside the 0–1 region. This implies that the respondents (adopters and non-adopters) in this study had unique characteristics making the match overlap without exceeding the range of values.
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Figure 1. A common support graph for propensity score estimation.

The propensity scores of adopters and non-adopters (treated and untreated) further showed that 96% of the respondents’ profiles were matched while 4% of the profiles were dropped (Table 2) suggesting the fitness of the model.

Table 2. The propensity score matching outcome.

| Treatment assignment | Off support | On support | Total |
|----------------------|-------------|------------|-------|
| Treated              | 3           | 87         | 90    |
| Untreated            | 10          | 193        | 203   |
| Total                | 13          | 280        | 293   |
Source: Author’s computation (2017).

The impact of treatment for a farmer $j$, denoted $\delta j$, is defined as the difference between the potential outcome in case of the treatment and the potential outcome in the absence of the treatment:

$$\delta j = Y_1j - Y_0j$$  \hspace{1cm} (1)

In general, an evaluation seeks to estimate the mean impact of adoption which is obtained by averaging the impact across all the individuals in the population. This parameter is known as an Average Treatment Effect (ATE):

$$ATE = E(\delta) = E(Y_1 - Y_0)$$  \hspace{1cm} (2)

where $E(.)$ represents the average (or the expected value).
To further measure the impact of adoption on individuals who participated, the Average Treatment Effect on the Treated (ATT) was employed:

\[ ATT = E(Y_1 - Y_0 | D = 1) \]  

(3)

Finally, the Average Treatment Effect on the Untreated (ATU) measures the impact the adoption program would have had on those who did not participate:

\[ ATU = E(Y_1 - Y_0 | D = 0) \]  

(4)

The ATT which is used to determine the impact on the adopters was employed since we aimed to determine the impact of DTMA adoption on the productivity and poverty status of the farmers and this can be written as:

\[ ATT = E(Y_1 | D = 1) - E(Y_0 | D = 1) \]  

(5)

where \( E(Y_0 | D = 1) \) is the average outcome that the treated individuals (adopters) would have obtained in the absence of treatment (adoption) and \( E(Y_0 | D = 0) \) i.e. the value of the \( Y_0 \) for the non-adopters. From this, we can, therefore, calculate \( \Delta \) as:

\[ \Delta = E(Y_1 | D = 1) - E(Y_0 | D = 0) \]  

(6)

The difference between \( \Delta \) and the ATT is such that the term \( E(Y_0 | D = 1) \) is added and subtracted:

\[ \Delta = ATT + E(Y_0 | D = 1) - E(Y_0 | D = 0) \]  

(7)

\[ \Delta = ATT + SB \]  

(9)

The term \( SB \) is the selection bias which is the difference between the counterfactual for adopters and the observed outcome for the non-adopters.

The simulation-based sensitivity analysis was done to determine whether an unobserved confounding binary variable could cause the ATT estimate to be zero or not under the assumption that this variable simultaneously affects a treatment assignment and the outcome variable (Nannicini, 2007). However, the sensitivity of the estimated results with respect to a hidden bias would indicate that the results are not robust (Caliendo and Kopeinig, 2008).

The Rosenbaum method of sensitivity analysis relies on the sensitivity parameter gamma (\( \Gamma \)) that measures the degree of departure from the random assignment of the treatment. Two subjects with the same observed characteristics may differ in the odds of receiving the treatment by at most a factor of \( \Gamma \). In a randomized experiment, the randomization of the treatment ensures that \( \Gamma = 1 \). In an observational study, if \( \Gamma = 2 \), and two subjects are identical on the matched covariates, then one might be twice as likely as the other to receive the treatment because they differ in terms of an unobserved covariate (Rosenbaum, 2005).

Changes in the poverty level of DTMA adopters and non-adopters were measured using the Foster, Greer and Thorbecke (1984) classes of the poverty index (FGT) which include the Headcount Index (\( P_0 \)), Poverty Gap Index (\( P_1 \)) and Severe Poverty Index (\( P_2 \)). These three indices can be compressed into one general formula and distinguish themselves with the different weights attributed to the
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Distance between the expenditure of the poor and the poverty line. The $P_0$ attributes equal weight to all expenditure of the poor, while $(P_1)$ and $(P_2)$ attribute increasingly more weight to the distance of the expenditure of the poor from the poverty line. They are widely used because they are consistent and additively decomposable (Verme, 2003).

$$FGT_{\alpha} = \frac{1}{M} \sum_{i=1}^{r} \left( \frac{z - y_i}{z} \right)^{\alpha}$$  \hspace{1cm} (10)

where:

$M =$ the total number of individuals in reference population;
$r =$ the number of individuals below the poverty line;
$z =$ the poverty line obtained as $2/3$ mean per capita annual expenditure;
$y_i =$ the annual per capita expenditure of the household $i$, and
$\alpha =$ degree of aversion ($0, 1, 2$).

In this study, we estimated the poverty incidence among adopters and non-adopters of DTMA in the study area (that is, $\alpha = 0$).

Results and Discussion

There was a significant difference between the household sizes of adopters and non-adopters. This implied that the adopters had more household members than the non-adopters (Table 3). The means of the age and farm size of adopters were not significantly higher than those of non-adopters, while the means of the years of farming experience, years of education and distance to a seed source of non-adopters were not significantly higher than those of adopters.

Table 3. The difference in the means between continuous socio-economic characteristics of adopters and non-adopters.

| Variables                        | Adopters Mean | Adopters S.D. | Non-adopters Mean | Non-adopters S.D. | t-value  |
|----------------------------------|---------------|---------------|-------------------|-------------------|---------|
| Age                             | 44.7          | 1.264         | 46.09             | 0.790             | 0.059   |
| Household size                  | 9.167         | 0.563         | 6.801             | 0.252             | -4.446*** |
| Years of farming experience     | 25.528        | 0.1386        | 25.877            | 0.871             | 0.218   |
| Years of education              | 8.122         | 0.644         | 8.710             | 0.487             | 0.680   |
| Field size                      | 5.593         | 0.460         | 5.210             | 0.361             | -0.133  |
| Distance (nearness) to a seed source | 42.944        | 4.031         | 44.859            | 2.889             | 0.380   |

Source: Author’s computation (2017). *** represents one percent level of significance.

Determinants of adoption of DTMA

The result of the logit model had a log-likelihood of -140.2772 and a Chi-square value of 71.60, which was significant ($p<0.01$) suggesting that the model
has a strong explanatory power capable of jointly influencing the adoption of DTMA (Table 4). Nine variables were found to significantly influence the adoption of the DTMA in the study area. The age is expected to signify experience and sound judgment. A year increase in the age of the farmer increased the probability of adopting DTMA by 0.0319 unit. Thus, older farmers were more likely to adopt DTMA than younger ones and this is consistent with the finding of Etoundi and Dia (2008) and Ademiluyi (2014) on the adoption of improved maize varieties in Cameroon and Nigeria, respectively. Education was positively related to the adoption of DTMA. This suggests that a literate household recognized the benefits of adoption to influence their productivity level. This is consistent with findings of Ersado et al. (2004) and Sewando et al. (2013), who have reported that educated household heads are more likely to adopt new and improved technologies as compared to the uneducated heads.

Proximity to the source of the DTMA seed increases the log-likelihood of a farmer adopting DTMA. The positive relationship further explains that an additional kilometer to the seed source will increase the probability of adoption by 0.0061 unit. It can be concluded that farmers whose homesteads were closer to the seed source were more likely to adopt DTMA than those whose households were farther away, which is an advantage to those closer to the seed source. This buttressed the findings of Idrisa et al. (2012) that distance to the technology source was positively related to the log-likelihood of adoption and the extent of adoption of improved soybean in Borno State, Nigeria.

Table 4. Determinants of DTMA adoption.

| Variables                          | Coefficient | Standard error | Marginal effect | Standard error |
|-----------------------------------|-------------|----------------|-----------------|----------------|
| Constant                          | -4.6443**   | 0.9188         |                 |                |
| Gender                            | -0.5746     | 0.4122         | -0.2098         | 0.1616         |
| Age                               | 0.0319***   | 0.0104         | 0.0104          | 0.0034         |
| Education                         | 0.0359***   | 0.0143         | 0.0117          | 0.0047         |
| Marital status                    | 0.1729      | 0.4145         | 0.0532          | 0.1205         |
| Distance to a seed source         | 0.0189**    | 0.0084         | 0.0061          | 0.0028         |
| Household size                    | -0.0389*    | 0.2225         | -0.0126         | 0.0073         |
| Farming experience                | -0.0009     | 0.0098         | -0.0003         | 0.0032         |
| Farm size                         | -0.0365*    | 0.0201         | -0.0118         | 0.0065         |
| Access to credit                  | 0.5501*     | 0.2945         | 0.1976          | 0.1136         |
| Land ownership                    | 1.0085***   | 0.5663         | 0.2252          | 0.0701         |
| Member of a farmers’ group        | 0.7410***   | 0.1892         | 0.2496          | 0.0651         |
| Training on improved practices    | 0.4380      | 0.6051         | 0.1578          | 0.2349         |
| Awareness and access to seed      | 1.4680**    | 0.6549         | 0.5063          | 0.2109         |

Chi² = 71.60; Log-likelihood = -140.27717; Chi² = 71.60

Source: Author’s computation (2017). *, ** and *** represent 10%, 5% and 1% levels of significance, respectively.
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Large household sizes may ensure an adequate supply of family labour for crop production and the adoption of improved agricultural technologies (Melesse, 2015). However, this study found that larger households may not adopt DTMA. Larger households had low per capita expenditure, were poor and could be cash-constrained to purchase improved seed. An additional member in the household decreased the log-likelihood of the adoption of DTMA by 0.0126 unit, which is in line with the finding of Audu et al. (2014) that household size was negatively related to the adoption of improved maize variety in Benue State, Nigeria. However, this is in contrast with the findings of Bamire et al. (2002) that household size was positively related to the adoption of improved technology. A unit increase in the farm size decreased the probability of adopting DTMA by 0.0118 unit. It, therefore, suggested that the majority of the small-holder farmers were more likely to adopt DTMA than bigger farms with irrigation technology. This finding is consistent with Adekoya et al. (2014) and Baruwa et al. (2015).

Access to credit was positively related to the decision of the farmer to adopt DTMA. This is because access to credit is a motivation for the farmer to produce more and corroborates the finding of Baruwa et al. (2015) that access to credit will increase the likelihood of adopting improved maize variety in Osun State, Nigeria. However, it is in contrast with the findings of Beke (2011) that access to credit had a negative significant effect on the adoption and use intensity of improved varieties in Ivory Coast. It can, therefore, be concluded that credit constraint will more likely reduce the likelihood of adoption of improved varieties because the farmers may not have sufficient income to encourage adoption.

Ownership of land increases the probability of a farmer adopting DTMA suggesting that ownership of land gives the farmer a high level of security on the land. Hence, farmers would want to acquire the land to increase maize productivity through adoption of DTMA. This corroborated the findings of Haliu et al. (2005) that land ownership significantly influenced the adoption of agricultural technologies in northern Ethiopia. Similarly, the interaction of the farmer between the time of awareness and access to seed positively influenced the adoption of DTMA. Thus, quick awareness and easy access to seed hastened the decision to adopt DTMA, which is consistent with the finding of Afolami et al. (2015) that a unit increase in access to improved cassava cutting within southwestern villages had a likelihood of increasing farmers’ adoption of improved cassava varieties. Furthermore, being a member of a farmers’ group positively influenced the decision of a farmer to adopt the DTMA variety. This further emphasized that a farmer in an association had a higher opportunity of adopting DTMA than those who were not members. In addition, membership of a group can provide easy access to farm inputs for the farmers, which is consistent with the findings of Onumadu and Osahon (2014) that membership of a group influenced the adoption of improved rice technologies in south-southern Nigeria.
The observed difference in the household expenditure and yield of adopters and non-adopters

The observed mean difference between adopters and non-adopters is presented in this section. The mean yield of maize and mean per capita household expenditure of adopters were significantly different from and higher than values for non-adopters (Table 5). However, there was no significant difference between the per capita food expenditure of both adopters and non-adopters.

Table 5. The difference in means between adopters and non-adopters.

| Variables                  | Adopters  | Non-adopters | Pooled       | Difference | t-value |
|----------------------------|-----------|--------------|--------------|------------|---------|
| Per capita household       | 27762.44  | 23058.71     | 24503.54     | -4703.73   | -5.10***|
| expenditure               |           |              |              |            |         |
| Total household expenditure| 558207.5  | 156086.1     | 279604.6     | -402121.4  | -2.05** |
| Yield of maize             | 13195.81  | 9530.24      | 10656.18     | -3665.58   | -1.81*  |
| Per capita food expenditure| 4601.99   | 2687.32      | 3281.53      | -1914.68   | -1.23   |
| Per capita non-food        | 4144.74   | 1964.08      | 2640.83      | -2180.67   | -5.84***|
| expenditure               |           |              |              |            |         |

Source: Author’s computation (2017). *, ** and *** represent 10%, 5% and 1% levels of significance respectively.

The impact of the adoption of DTMA on the productivity and poverty status of maize farmers

To examine the impact of DTMA adoption on the yield and poverty status of the farmers in the study area, kernel propensity score matching was used to check whether there was the statistical difference between the means of the matched variables and the average treatment effect. The propensity score was a probability which is an interval (0, 1) (Table 6). The independent variables had an average effect of 32% on the probability of farmers adopting the DTMA, indicating the population had 32% chance of adopting DTMA with respect to the outcome variable (yield and poverty).

The adoption of DTMA had a significant treatment effect on the treated (t-statistic = 2.18), suggesting that there was a significant difference between the matched and the unmatched respondents. Thus, the adoption of DTMA increased the productivity of the adopters. The ATT measured the impact of the program on DTMA adopters and revealed an increase of 9,262.77kg/ha in productivity of adopters. The counterfactual outcome, ATU, measured the impact of adoption on those who did not adopt DTMA and indicated an increase of 3,807.74kg/ha. This implied that non-adopters would have had an increase of 3,807.7kg/ha in their productivity if they had adopted DTMA. The ATE on the entire population in the
study area (i.e. picking any farmer at random) which measures the average impact across all respondents was 4,903.66kg/ha (Table 6).

Table 6. The impact of DTMA adoption on yield and poverty.

| Variable        | Sample | Treated     | Control    | Difference | t-test |
|-----------------|--------|-------------|------------|------------|--------|
| Yield           | Unmatched | 13070.51   | 9036.19    | 4034.32    | 1.35   |
|                 | ATT     | 13070.51   | 3807.74    | 9262.77    | 2.18** |
|                 | ATU     | 9036.19    | 12109.02   | 3072.83    |        |
|                 | ATE     |            |            | 4903.66    |        |
| Poverty incidence | Unmatched | 0.3444     | 0.4778     | -0.1334    | -2.13**|
|                 | ATU     | 0.3444     | 0.1182     | -0.3596    |        |
|                 | ATE     |            |            | -0.4334    |        |

Source: Author’s computation (2017). *, ** and *** represent 10%, 5% and 1% levels of significance, respectively.

Furthermore, the adoption of DTMA reduced the probability of being poor by 60 percent for the treatment group (ATT) while the ATE implied that if DTMA was adopted, the poverty level of the farmer would reduce by 43 percent. The ATU indicated that the poverty level of the farmers was reduced by 35% among the non-adopters, corroborating the findings of Manale et al. (2010) that the adoption of improved groundnut varieties had a positive impact on the rural household poverty status in Uganda. In addition, there was a 12-fold increase in the difference between the unmatched and the treated (Table 6). These findings gave an evident positive impact of the adoption of DTMA on the poverty status of the farmers.

Table 7. Rosenbaum sensitivity analysis results.

| Gamma (Γ) | sig+  | sig-   | t-hat+ | t-hat-  | CI+     | CI-     |
|-----------|-------|--------|--------|---------|---------|---------|
| 1         | 0.373389 | 0.373389 | 494.4  | 494.4   | -2352.7 | 3006.56 |
| 1.2       | 0.60218 | 0.182082 | -344.5 | 1195.2  | -3540   | 3962.5  |
| 1.4       | 0.774111 | 0.79655  | -1115  | 1738.5  | -4604.1 | 4768.44 |
| 1.6       | 0.881679 | 0.032365 | -1603.5| 2382.8  | -5117.5 | 5827.78 |
| 1.8       | 0.941545 | 0.012489 | -2281.8| 2850.3  | -6095.8 | -        |
| 2         | 0.97234 | 0.004643 | -2587.1| 3414.2  | -7338.3 | 7770.33 |
| 2.2       | 0.987329 | 0.00168  | -3281.8| 3716.4  | -8314.1 | 9327.78 |
| 2.4       | 0.994337 | 0.000595 | -3640  | 4053.6  | -8867.9 | 14916   |
| 2.6       | 0.997518 | 0.000208 | -4140.4| 4500    | -9666.7 | 17530.5 |
| 2.8       | 0.998929 | 0.000071 | -4644.4| 4802    | -10048 | 18940   |
| 3         | 0.999543 | 0.000024 | -4870.8| 5290.3  | -10891.8| 19845   |

Source: Author’s computation (2017). *Gamma = log odds of the differential assignment due to unobserved factors: sig+ = the upper bound significance level, sig- = the lower bound significance level, t-hat+ = the upper bound Hodges-Lehmann point estimate, t-hat- = the lower bound Hodges-Lehmann point estimate, CI+ = the upper bound confidence interval (a= 0.95), and CI- = the lower bound confidence interval (a= 0.95).
Results showed that for $\Gamma = 1$, the odds ratio of the treatment was the same for any two units matched on the same number of covariates (Table 7). The estimate was highly robust as Hodges-Lehmann point estimates encompassed zero at gamma=1.2. Thus, the DTMA adoption program had a positive treatment effect and estimates were almost free from unobserved covariates, thereby concluding that the overall results were remarkably robust and the analysis supported the robustness of the matching estimates.

Conclusion

The impact of the adoption of DTMA on the yield and poverty status of farmers in the northwestern region of Nigeria was assessed in the study. The adoption of DTMA was positively influenced by age of the farmer, years of education, land ownership, distance (nearness) to a seed source, awareness and access to seed, access to credit and membership of a farmers’ group while it was negatively influenced by the farm size and household size. Thus, education and farming experience were found to determine the farmers’ decision to adopt the DTMA. Hence, this emphasizes the importance of human capital development by ameliorating the farmers’ access to agricultural knowledge, improved skills and gain more experience. Facilitating access to DTMA varieties by farmers would ensure higher maize yield for farmers and consequently reduce the incidence of poverty among them. For sustainable increased maize productivity and poverty reduction among farmers, the Nigerian government should review land-use decree and facilitate agricultural credit scheme to farmers in order to increase the level of land ownership by farmers and investment in large-scale DTMA production that will address the challenges facing agriculture’s contribution to food security.

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KAKAV UTICAJ KORIŠĆENJE KUKURUZA TOLERANTNOG NA SUŠU ZA AFRIKU IMA NA PRINOS I STATUS SIROMAŠTVANJA POLJOPRIVREDNIKA U SUŠNOM PODRUČJU NIGERije?

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R e z i m e

Proizvodnja kukuruza u Nigeriji nije uspela sa zadovoljno potreba ljudi usled suše, niske produktivnosti i nedostatka pristupa poljoprivrednikima boljšim varijetetima. Povećani poljoprivredni prinos je moguće sredstvo za povećanje prihoda domaćinstva, s ciljem da se smanji siromaštvo nosilaca malih poljoprivrednih gazdinstava. Ovim istraživanjem se procenjuje uticaj kukuruza tolerantnog na sušu za Afriku (engl. Drought-Tolerant Maize for Africa – DTMA) na prinose i na status siromaštva poljoprivrednika u severozapadnom području Nigerije. U istraživanju su korišćeni podaci iz Ankete u vezi sa korišćenjem kukuruza tolerantnog na sušu za Afriku, koju je sprovedu Međunarodni institut za tropsku poljoprivredu u Ibadanu, sa 293 ispitanika iz severoistočne Nigerije (90 onih koji su koristili i 203 onih koji nisu koristili DTMA). Podaci su analizirani korišćenjem deskriptivne statistike, binarne regresije i metode uparivanja prema srodnosti. Rezultati su pokazali da je verovatnije da će nosioci malih gazdinstava pre usvojiti DTMA nego veća gazdinstva. Korisnici su imali povećanje prinosa DTMA od 9.262,77 kg/ha dok su oni koji nisu koristili DTMA imali povećanje od 3.807,74 kg/ha. Korišćenje DTMA smanjilo je verovatnoću siromaštva za 60% za postranu grupu, dok je učestalost siromaštva smanjena za 35% među onima koji nisu bili korisnici. Opšti je zaključak da je program korišćenja DTMA poboljšao prinose kukuruza i smanjio učestalost siromaštva među poljoprivrednim gazdinstvima.

Ključne reči: DTMA, siromaštvo, Sudanska savana, metoda uparivanja prema srodnosti, severozapadna Nigerija.

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