POLICY BRIEF No.16

September, 2017

UNU-INRA

Climate Change Adaptation Options: Importance of Drought Tolerant Maize Seeds

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EXECUTIVE SUMMARY

Maize production remains an important option for achieving food security and income generation among smallholder farmers in sub-Saharan Africa. However, the incidence of climate change in recent years has resulted in the need for better adaptable maize varieties in semi-arid regions. This research evaluated the performance (yields and profits) of drought tolerant (DT) hybrid and open pollinated varieties (OPV), using on farm trials under different localities. The findings of the study indicated that DT maize hybrid yields (9234.77 to 11755.18 kg/ha) were higher than the yields of OPV (5029.69kg/ha to 7165.98kg/ha). Much of the variance in maize yield was attributed to climatic variables such as the amount of rainfall and the number of rainy days in the season. Furthermore, maize hybrid production was more profitable than the OPV-based production system. The results suggest the importance of promoting maize hybrid seeds among farmers through on-farm trials and field days. It is also crucial to re-examine existing maize seed and agricultural extension policies to ensure improved agricultural productivity.

INTRODUCTION

Agriculture, which is the main economic activity in terms of employment share, is 98% rainfed in sub-Saharan African (SSA) countries. Stagnant agricultural yields, relative to the region's population growth, have led to a fall in per capita food availability since the 1970s (Cairns et al., 2013). This situation may be complicated further by changes in rainfall variability and extreme weather events that are affecting the agriculture sector.

Maize (*Zea mays* L) is one of the principal staple crops in SSA with an average yield of less than 2.0t ha^{-1} largely due to drought stress, low soil fertility, parasitic weeds, low input use and inappropriate seeds.

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Empirical evidence reveals that maize yield has significantly reduced by 15 to 17% in the humid tropics compared to well-watered conditions, and when drought occurs during or shortly before flowering. The estimated yield loss may be in the range of 21 to 50% (DT Maize Bulletin, 2014). Promotion of appropriate technologies that increase farmers' resilience to climate change manifestations such as droughts and dry spells is an important step to increasing grain yield so as to reduce poverty among resource-limited farmers. This policy brief seeks to highlight the performance of drought tolerant (DT) hybrids and open pollinated maize varieties (OPVs) for their suitability as cultivars in different locations of the southern Guinea savanna (SGS) zone of Nigeria. It also aims to determine the effect of climate change on maize grain yield and estimate the economic impact of DT maize production.

Approach

Data pooled from drought tolerant maize for Africa (DTMA) trials collected between 2007 and 2014 on different maturity groups among open pollinated varieties (OPVs) and hybrids were selected and analyzed.

Performance of Drought Tolerant (DT) Maize Genotypes

The results showed that grain yield across the environments ranged from 5029.69kg/ha to 7165.98kg/ha for drought tolerant open pollinated varieties while hybrids yielded between 9234.77 and 11755.18 kg/ha. The environment contributed more, as about 70% of the yield differences were due to the environment, indicating the variability of locations in the southern Guinea savanna (SGS) region. The analyses identified suitable genotypes for the ideal environment as presented in Table 1 below. These locations can be utilized by seed companies or individuals for the production of particular maize maturity group(s).

Table 1: Suitable drought tolerant (DT) maize genotype for ideal location in SGS - Nigeria

Genotype	Ideal Cultivar	Mean Grain yield ($kgha^{-1}$)	Suitable Locations	
Early Maturing DT OPVs	TZE-Y DT STR C_4	7165.98	Ilorin	Ballah
Intermediate/Late DT OPVs	White DT STR SYN	5518.14	Ejiba	Mokwa
Early Maturing DT Hybrids	TZE-W POP DT STR C_5	9606.85	Ilorin	Mokwa
Extra Early DT Hybrids	TZEEI 3 x TZEEI 46	9798.16	Kishi	Ballah

Impact of Environmental Changes on Performance of Drought Tolerant Maize

In the southern Guinea savanna of Nigeria, yields are constrained by long dry seasons, high temperature and general unpredictability of rain during critical crop growth stages. The study found that the amount of rainfall and raining days, air temperature, relative humidity and sunshine, impact either positively or negatively on drought tolerant maize production.

The results show that maize yields increase with more seasonal rainfall and decrease with higher temperatures. However, increase in the number of days without rainfall during the growing season reduces yields of maize. This implies that, farmers need to adjust maize planting and growing period to correspond with raining days based on rainfall forecast.

Table 2: Regression results for effect of environmental change on DT maize grain yield in southern Guinea savanna of Nigeria

Variable	Coefficient	Std. Error	t-Stat	Probability level
Intercept	1366.847	3904.162	0.350	0.729
Annual Rainfall	20.422	8.697	2.348	0.026*
Max. Temperature	-180.177	119.232	1.511	0.142
Min. Temperature	-170.900	94.695	-1.805	0.082
Rel. humidity	41.615	24.651	1.688	0.103
Soil Temperature	-19.254	27.383	-0.703	0.048*
Sunshine hours	-78.928	30.408	-2.596	0.015*
Cropping Rainfall	17.958	75.709	0.237	0.035*
Cropping Rainy Days	80.135	83.232	0.963	0.037*

R =0.597, R^2 = 0.357, Adj. R^2 = 0.214, SE = 1311.816, Durbin-Watson= 2.71, significance at 5% level.

Economic Estimate for Producing Drought Tolerant Maize

The cost of producing one hectare of any maize variety was between ₦122,000 and ₦125,000 (about US$ 613). The profit per hectare for open pollinated varieties ranged from ₦ 94,258.40 (about US$473) to ₦ 133,056.80 (about US$668), whereas hybrids production profit was about ₦282,124.80 (US$1,417) compared to ₦ 38, 064.00 (about US$191) profit of farmer's non-drought tolerant variety. Maize production using drought tolerant hybrid cultivars in the southern Guinea savanna is a highly profitable venture, because every ₦1 invested in the production of maize hybrid brought a return of ₦3.32. It is therefore advisable to take advantage of the high profitability of maize hybrid production in the region and invest in its production, so as to increase income and reduce the level of poverty in the zone.

Table 3: Profitability analysis of cultivating drought tolerant maize in southern Guinea savanna of Nigeria

DT Maize	[1]Grain yield (kg/ha)	[2]Price (₦/kg)	Production Cost (₦)	Maize Output (₦)	Profit ₦	Profit US$	BCR	Efficiency (%)
Early DT OPVs	3188.21	80.00	122,000	255,056.80	133,056.80	668.46	2.09	47.83
Int/Late DT OPVs	2703.23	80.00	122,000	216,258.40	94,258.40	473.54	1.77	56.41
Early DT Hybrids	5057.81	80.00	122,500	404,624.80	282,124.80	1,417.36	3.30	30.27
Extra Early DT Hybrids	5102.41	80.00	122,500	408,192.80	285,692.80	1,435.28	3.33	30.01
Farmer's Variety	2000.80	80.00	122,000	160,064.00	38,064.00	191.24	1.31	76.22

[1] = 50% of experimental field yield, [2] = CBN Bulletin (2014), [3] = seed rate of 20kg/ha for OPVs and 15kg/ha for hybrids, BCR = benefit-cost ratio

Policy Considerations

The study has shown that continuous reliance on rainfed agriculture increases the vulnerability of maize production to climate variability. It also revealed that increase in maize grain yields depends on the specific locations and suitable varieties. Below are some suggested measures that should be considered by stakeholders in addressing the impact of climate change on maize grain yields:

(i) The country's Meteorological Agency needs more funds to procure latest equipment for weather forecasting and make records available to local communities;

(ii) It is important to create more awareness on drought tolerant (DT) certified seeds use to improve demand among farmers. This could be done through field demonstrations and adequate local media education;

(iii) In addition, provision of improved rural infrastructure would encourage private seed companies to expand sales networks to rural areas;

(iv) There is also the need to increase the extension-farmer ratio, and make extension services more accessible to farmers.

References

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Acknowledgement

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada.

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This Policy Brief is prepared from a UNU-INRA Working Paper entitled:

Green Strategy for Maize Varietal Selection and Identification of Suitable Sites in Drought-Prone Ecologies in Southern Guinea Savanna of Nigeria

This policy brief and the working paper are available at collections.unu.edu

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