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Evaluation of Women's On-Farm Trial of Drought Tolerant Maize in Southern Guinea Savannah Agro-Ecological Zone of Nigeria

O. E. Ayinde, T. Abdoulaye, G. A. Olaoye,
and A. O. Oloyede

5.1 Introduction

The importance of food security in Africa cannot be overemphasized. This is seen in the growing discussions and efforts made in meeting the food security challenge such as the translation from Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs). To solve the food security challenge, there is a need to increase agricultural production through technological innovations to boost production in Africa. However, this must be achieved against a backdrop of issues such as climate change and droughts amongst others (Global Food Security Index 2015). Drought is the most devastating and costly challenge to crop production because farmers in Africa practise rain-fed

O. E. Ayinde (✉) • G. A. Olaoye • A. O. Oloyede
University of Ilorin, Ilorin, Nigeria

T. Abdoulaye
International Institute of Tropical Agriculture, Ilorin, Nigeria

agriculture (Ayinde et al. 2016). Many farmers in Africa are faced with significant reduction in yield due to drought. Fisher et al. (2015) stated that yield losses of about 10–25% are recorded from around 40% of Africa's maize-growing areas due to drought stress. It is estimated that by 2030 drought and rising temperatures could render Africa's maize-growing areas unsuitable for current varieties (CGIAR Big Facts). In addition, it is expected that by 2050 population growth and changing diet will resultantly increase the demand for maize in the developing countries double fold (CIMMYT and IITA 2015). There is also a prediction of an annual 1.3% growth rate in demand for human consumption of maize in the developing world until 2020 (Ortiz et al. 2010).

This has implications to sub-Saharan Africa, where an array of factors contributes to a sharply increasing demand for maize, including maize being a staple food for an estimated 50% of the population (Olaniyan 2015) and its importance in addressing the issues related to food security and economic wellbeing. Maize is the most widely grown crop and in terms of food security, it is the most important cereal crop in sub-Saharan Africa (Olaniyan 2015, IITA). Out of 53 countries in sub-Saharan Africa, 46 grow maize. For instance, Nigeria has the largest land area under maize production (seventh in the world and 2.4% of the total land area) and ranks amongst the top producers (FAOSTAT 2010). Bamire et al. (2010) indicated that maize production in Nigeria is of strategic importance for food security and the socio-economic stability of the country and sub-regions in sub-Saharan Africa. However, recurring droughts has been a continuous challenge to the production of this important crop by drastically reducing yields and livelihoods. Report has it that around 25% of the maize crop suffers frequent drought, with losses of up to half the harvest in the country (CIMMYT 2013). As a result, new maize varieties will have to be developed quickly and growing in farmers' fields in the next few years if we are to avoid widespread famine in Africa (CGIAR Big Facts).

In a response to these challenges, the Drought Tolerant Maize for Africa (DTMA) project has made releases of 160 DT maize varieties, between 2007 and 2013 (Fisher et al. 2015). The International Institute of Tropical Agriculture (IITA) and International Maize and Wheat Improvement Center (CIMMYT) have been the leading force in DT

maize variety research in Nigeria (Ayinde et al. 2016). The DT maize varieties, which have demonstrated superiority for grain yield, have been selected annually for testing under farmer's growing conditions in the northern and southern guinea savanna zones of the country. Ayinde et al. (2013) stated that the use of DT maize varieties stabilize maize yields in drought prone ecologies in the country. The development, dissemination and adoption of DT maize varieties, therefore, have the potential of reducing vulnerability and food insecurity (Bamire et al. 2010).

Central to these are the small-scale, resource-poor farming households living in the more marginal rain-fed agricultural areas. In Nigeria, agriculture is predominantly in the hands of rural smallholder farmers who are responsible for more than 70% of the agricultural production in the country (Enete and Amusa 2010). According to African Development Bank (AFDB) (2015), women constitute almost 50% of the agricultural labour force, yet they receive a significantly lower share of income with an estimated rural wage gap of 15–60% between men and women in the same sub-sector.

Despite women's contribution to agriculture, the rural economy and food security in the country, their ability to obtain agricultural inputs is directly constrained by gender discrimination (Simonyan et al. 2011). Soyemi (2014) stated that in a bid to increase productivity of rural farmers in the country, agricultural policies and programmes have focused on development and transfer of appropriate technologies. However, the constraint to such an approach especially for women farmers are that most agricultural technologies are being designed on the assumption that farm managers are men (Simonyan et al. 2011). In addition, even when women own the land, they tend to have limited access to financing, quality inputs, extension services and knowledge of agricultural practices. Ajadi et al. (2015), Soyemi (2014), Adeyemo et al. (2015), and Koyenikan and Ikharea (2014) found that women had less access to agricultural resources and information on agricultural technologies. Beuchelt and Badstue (2013) in a study emphasized that the reduction of gender disparities and the empowerment of women leads to better food and nutrition security for households and significantly strengthens other development outcomes such as child education.

It is therefore necessary for farmers to have access especially to agricultural technologies as this will contribute to both food security and economic

growth. One of the ways to creating access to agricultural technologies and innovations is the on-farm trial method. On-farm trial is a farming systems approach which includes farmers' participation and helps farmers gain access to new technology earlier, improves farmers' knowledge and experience and encourages feedback between farmers and researchers that can allow for modifications as the growing season progresses. The method also improves farmers' capacity and expertise for conducting collaborative research and can encourage wider adoption of the technology. However, there has been lesser participation of women in on-farm trials. Women's involvement in on-farm trials has been limited and they have been left out of decision-making and evaluation of trials as well as related training (Lahai 1994). In a study in Sierra Leone, Lahai (1994) found that the focus of the extension instructor for the on-farm trials was on the women's husbands despite the fact that the women contributed significantly to the labour for the on-farm research. Saito et al. (1994) also noted that new technology may not be adopted because of the failure to adequately involve women in technology design and implementation. This study is therefore designed to evaluate women's on-farm trial of DT maize varieties in Southern Guinea Savannah zone of Nigeria. According to Norman et al. (1995), evaluation of on-farm trials includes the technological, economic and social analysis. Based on this, the specific objectives of the study are to identify women farmers' preference and evaluate the profitability of the women farmers in new variety production. Women's integration in the testing of agricultural technological innovation such as DT maize has to be examined to enhance gender equity in the use of agricultural technology (DT maize) so as to improve adoption and productivity. Consequently, a gender-balanced agricultural growth is critical to increases in food security and attainment of the SDGs (Ayinde et al. 2012).

5.2 Materials and Methodology

5.2.1 Description of Experimental Materials

Ten DT open pollinated varieties (OPVs) of maize were tested in farmers' fields in Kwara, Niger and Oyo states of the southern guinea savannah

(SGS), using on-farm trial approach through women groups. A total of ten kilograms of seeds were distributed among the farmers. The seeds of the improved DT OPVs were provided by IITA to the participating farmers. Furthermore, apart from the on-farm trial, approximately five kilograms of seeds were distributed to women as seed drop to promote production of DT maize varieties.

5.3 Method

Seven villages were selected for study. Four villages out of the selected villages had participated in the DT on-farm trial before while the remaining three villages were new. Sensitization was done through visits to the villages. Several meetings were held with the women in the selected villages and collaborators (scientists) from Agricultural Development Projects (ADP) extension agents were in attendance. The purpose for this was proper briefing on the objectives, scope and modality for executing the activities of the project. Women groups were formed in each of these villages: Mokwa, Kishi, Omupo, Lajiki, Arandun, Ballah and Isanlu Isin. This makes a total of seven groups. Each group consists of a minimum of 10 members and a maximum of 20 members. This was done for effectiveness in communication within the groups.

The women groups were trained on correct agronomic practice to enable them understand how to carry out the on-farm trials. The advantages of DTMA were highlighted to the participating women farmers. A plot was marked out for each group for on-farm trials. The plot size for the on-farm trials which included two DT maize varieties and a farmer's variety (sandwiched between the two DT varieties) as check was 10 m × 10 m. Maize was planted at an intra-row spacing of 50 cm on 75 cm wide ridges. The fields were kept weed free by the farmers while NPK Fertilizer was applied as split dosage at 4 and 7 Weeks After Planting (WAP) respectively using the recommended dosage in each zone.

The women groups were given extra seeds to plant on their individual farms. Seeds were also given to women who were not part of the group but who were interested at some of the selected villages. Two monitoring tours were undertaken to each farming community during the year. These

were at the vegetative and flowering phases of the crops, respectively. The visit at the vegetative phase was to further explain the details of the protocols to ensure compliance to the details in the protocols and to collect data at this growth stage. The visit at the flowering phase was essentially for data collection at this phase. Collection of crop performance data from the on-farm trials was undertaken in conjunction with scientists and participating farmers especially during the flowering period. Data were collected essentially on yield parameters. Two estimates of yield (i.e. based on cob and seed yields) were obtained. Ears per plant (EPP) was estimated as a proportion of number of cobs harvested to total harvestable plants while seed to cob yield ratio was expressed as a proportion of yield estimated from cob and seed yield, respectively. Other socio-economic data were collected through questionnaires.

The sampling technique consists of a two-stage stratified sampling. At the first stage, eight women farmer groups were selected. The second stage involved a random selection of ten women farmers per group per location (village). The total number of farmers selected was 80.

5.3.1 Analytical Technique

Data collected from the trials were analysed. The analytical techniques used include descriptive statistic, ranking method and farm budgeting tool. Descriptive statistic such as frequency, averages, mode, mean and ranking technique which involved the use of a 3-Likert scale to analyse the socio-economic characteristics of the women farmers and their preference scores in the study area. Farm budgeting analysis was used to analyse the profitability of the DT maize varieties in the study area.

5.3.2 Farm Budgeting Analysis

The Gross margin analysis was used. Input quantities, factor prices, physical output and gross returns were used. Since the fixed cost constitutes a negligible portion of the total costs of production, the gross margin analysis was employed and used. It is given as:

$$GM_j = TR_j - TVC_j \quad (5.1)$$

where GM_j = Gross Margin (₦/ha), TR_j = Total Revenue (₦/ha), TVC_j = Total Variable Cost (₦/ha)

Returns to investment (RI) were also obtained. This was done by dividing gross margin (GM) by the total variable cost of production per hectare. The implicit form is shown below:

$$GM_j = TR_j - TVC_j \times \frac{100}{1} \quad (5.2)$$

where TR and TVC are as defined earlier.

5.4 Results and Discussion

5.4.1 Socio-Economic Characteristics of Women Farmers

The socio-economic profile of the women farmers is presented in Annex (Table 5.1). The result of the analysis revealed that the average age of farmers in the study area is 43 years with the oldest being 65 years and the youngest 22 years old. This implies that the women farmers are experienced in farming activities. About 23% of the female farmers were not educated. All the women farmers were married. The female farmers had an average farm size of 1.62 hectares. This implies that the women are less privileged to inputs and less involved in the decision-making process.

5.4.2 Women Farmer Variety Preference

Tables 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, and 5.8 in Annex revealed the women farmers preference per location. The women farmers at Lajiki preferred the TZEEI 95 × TZZEE 58 variety than the other varieties. This could be a result of the fast growth and deep green leaf colour of the plant.

The women farmers at Ballah preferred the TZEEI 81 $\times$ TZZEE 95 variety than the other varieties. This could be a result of the attractive look and high vigour of the stands. The result for Arandun showed that the women preferred the EVDT 99 variety the most. The variety was preferred because it has a lot of grain although the cob is small with small seeds than the other varieties and also because EVDT 99 was fast in growth and was able, to some extent, better withstand the climate than the other varieties. The women also indicated that had there been more rain, the variety would have produced better yield. The women group at Omupo and Isanlu Isin preferred the IWDC3 SYN $\times$ 21 White DT STR SYN-DT C1 variety than the others. This is due to the fact that the variety had fast growth and was tolerant to drought. The women group at Mokwa preferred the 2013 TZE-W DT STR. This is because the variety had bigger cobs.

5.4.3 Profitability of On-Farm Trial

Table 5.9 in Annex shows the profitability of the on-farm trials. The result shows that, at Lajiki, the TZEEI 95 $\times$ TZZEE 58 variety gave the highest yield (1560 kg/ha), highest profit of ₦33,400 and highest returns to investment of 90.8%. This implies that for every 1 naira spent, 90 kobo (0.90) was gained as returns. At Ballah, the TZEEI 81 $\times$ TZZEE 95 variety produced the highest yield (1539 kg/ha), highest profit of ₦32,985 and the highest (90.9%) returns to investment. This implies that the farmers gained 91 kobo (0.91) for every 1 naira spent. At Arandun, the 99TZEE-Y-STR variety produced the highest yield of 2649 kg/ha, the highest profits of ₦81,005 and the highest returns to investment of 212%. This implies that for every 1 naira used, a return of 2 naira, 12 kobo (2.12) was gained. At Omupo, the IWDC3 SYN $\times$ 21 White DT STR SYN-DT C1 variety produced the highest yield of 2630 kg/ha and gave the highest profit of ₦79,650 and highest returns to investment of 205%. This implies that about two naira five kobo (2.05) was gained for every one naira used for production. In general, the DTMA varieties had higher profitability. The DTMA varieties had better yield than the farmers' variety at all locations of the women group trials.

5.4.4 Reasons for Preference

The yellow colour of seed was the most preferred characteristic at all the locations. The yellow maize was preferred whether it was the improved variety or farmer's variety. This is due to the fact that the farmers claimed that the yellow maize was marketable and is of high demand in the market as well as it commands a better price in the market than the white maize. It is also believed that the yellow maize is more nutritious than the white maize. Other reasons for preference include cobs with full grains, big seed, big cobs, DT, big leaves, greenish leaf colour, strongly matured cobs, produce multiple cobs, tall stalks or good stand, high vigour and attractive look.

5.5 Conclusion and Recommendations

The study revealed that the women farmer's varietal preference differs across locations. The women farmers ranked the DT maize varieties as the best at all locations. The profitability of the DT maize varieties also differs per location with the DT maize varieties having the highest profit and returns to investment. There was a long period of drought and delayed onset of rainfall (erratic rainfall) which affected the crops and resulted in lower yield than in previous years. However, the successes of the on-farm trial encouraged the women farmers. It is therefore recommended that efforts should be made to involve women farmers in the varietal selection and testing procedure so as to ensure that the women farmers' preferences are incorporated in the development of agricultural technologies. This will help increase the farmers' yield and profitability from their production.

Finally, the study recommends that programmes and policies that will encourage women farmers' involvement in the development and testing of agricultural innovations should be implemented across the country in order to ensure food security and enhanced agricultural productivity.

Annexes

Table 5.1 Socio-economic characteristics of women farmers

Variables	Frequency	Percentage
<i>Age</i>		
<29 years	22	27.5
30–39 years	20	25.0
40–49 years	20	25.0
50–59 years	14	17.5
60 and above	4	5
Total	80	100
Mean age	43.11	
<i>Marital status</i>		
Single	4	5
Married	75	95
Total	80	100
<i>Level of education</i>		
No formal education	8	10
Primary education	42	52.5
Secondary education	20	25
Tertiary education	10	12.5
Total	80	100
<i>Farm size</i>		
1–5	80	100
6–10	0	0
Mean	1.92	

Table 5.2 Women farmer variety preference result for Lajiki

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
TZEEI 95 × TZEE 58	1	2	7	1st
TZEEI 81 × TZEE 95	2	3	5	2nd
Farmer variety	9	1	0	3rd

Table 5.3 Women farmer variety preference result for Ballah

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
TZEEI 95 × TZEE 58	2	3	5	2nd
TZEEI 81 × TZEE 95	0	2	8	1st
Farmer variety	4	5	1	3rd

Table 5.4 Women farmer variety preference result for Arandun

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
EVDT 99	0	2	8	1st
99TZEE-Y-STR	2	3	5	2nd
Farmer variety	4	5	1	3rd

Table 5.5 Women farmer variety preference result for Omupo

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
IWDC3 SYN × 21 White DT	0	1	9	1st
STR SYN-DT C1				
TZ COMP/ZDPSYN	0	3	7	2nd
Farmer variety	4	3	3	3rd

Table 5.6 Women farmer variety preference result for Isanlu Isin

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
IWDC3 SYN × 21 White DT	0	2	8	1st
STR SYN-DT C1				
TZ COMP/ZDPSYN	1	3	6	2nd
Farmer variety	7	1	2	3rd

Table 5.7 Women farmer variety preference result for Mokwa

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
2013 TZE-W DT STR	0	2	18	1st
2011 TZE-W DT STR SYN	2	4	14	2nd
Farmer variety	12	4	4	3rd

Table 5.8 Women farmer variety preference result for Kishi

Variety	Low Preference (1)	Medium Preference (2)	High Preference (3)	Rank
IWD C3 SYN/DT SYN-1-W	0	1	9	1st
2013 DTE STR-W SYN	1	2	7	2nd
Farmer Variety	6	2	2	3rd

Table 5.9 Economic analysis of the on-farm demonstration of women farmer group

Village	Variety	Yield (kg/ha)	Fertilizer costs		Other expenses	Total cost returns		Profit (Naira)	Return to investment
			(Naira)	(Naira)		(Naira)	(Naira)		
Lajiki	TZEEI 95 x TZZEE 58	1560	27,000		10,000	36,800	70,200	33,400	0.908
	TZEEI 81 x TZZEE 95	982	27,000		10,000	36,800	44,190	7390	0.201
Ballah	Farmer	797	27,000		10,000	36,800	35,865	-935	-
	TZEEI 95 x TZZEE 58	936	27,000		9270	36,270	42,120	5850	0.161
	TZEEI 81 x TZZEE 95	1539	27,000		9270	36,270	69,255	32,985	0.909
	Farmer	730	27,000		9270	36,270	32,850	-3420	-
Arandun	EVDI 99	2460	27,000		11,000	38,000	110,700	72,500	1.908
	99TZEE-Y-STR	2649	27,000		11,000	38,000	119,205	81,205	2.137
	Farmer	1281	27,000		11,000	38,000	57,645	19,445	0.512
Isanlu Isin	IWDC3 SYN x 21White DT	2630	27,000		11,600	38,600	118,350	79,750	2.066
	STR SYN-DT C1								
Omupo	TZ COMP/ZDPSYN	2549	27,000		11,600	38,600	114,705	76,105	1.972
	Farmer	1021	27,000		11,600	38,600	45,945	7945	0.205
	IWDC3 SYN x 21White DT	2630	27,000		11,600	38,600	118,350	79,750	2.066
	STR SYN-DT C1								
Mokwa	TZ COMP/ZDPSYN	2549	27,000		11,600	38,600	114,705	76,105	1.972
	Farmer	1021	27,000		11,600	38,600	45,945	7345	0.19
	2013 TZE-W DT STR	3460	27,000		11,000	38,000	155,700	117,700	3.097
	2011 TZE-W DT STR SYN	3649	27,000		11,000	38,000	156,105	118,105	3.108
Kishi	Farmer variety	2281	27,000		11,000	38,000	102,645	64,645	1.701
	2013 DTE STR-W SYN	4804	27,000		11,000	38,000	216,180	178,180	4.689
	IWD C3 SYN/DT SYN-1-W	4100	27,000		11,000	38,000	184,500	146,500	3.855
	Farmer variety	2280	27,000		11,000	38,000	102,600	64,600	1.7

Family labour cost was not assigned cost but similar labour time was used on each variety

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