Participatory Farmer Evaluation of Stem borer Resistant Maize varieties in three maize growing ecologies of Kenya

By

Ouma, J.O; Odendo, M.; Bett, C.; De Groote, H.; Mugo, S.; Mutinda, C.; Gethi, J.; Njoka, S.; Ajanga, S. & Shuma, J.

Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23, 2010.

Participatory Farmer Evaluation of Stem borer Resistant Maize varieties in three maize growing ecologies of Kenya

Ouma J.O[1]; M.Odendo[2] ; C.Bett[3]; H. De Groote[4]; S.Mugo[4]; C.Mutinda[1] ; J.Gethi[3] ; S.Njoka[1]; S.Ajanga[2] & J.shuma[5]

[1]KARI-Embu;Email: j_okuro@yahoo.co.uk; [2]KARI-Kakamega; [3]KARI-Katumani; [4]CIMMYT-Kenya & [5]KARI-Mtwapa

Abstract

Insect Resistant Maize for Africa Project (IRMA) aims at developing and deploying insect resistant maize varieties to reduce grain losses due to insect pests. As part of incorporating farmer's perceptions and improving the adoption of the developed varieties, participatory approaches are adopted. The paper analysis farmer's preferences of maize germplasm developed through conventional breeding. The paper uses data collected from evaluations conducted at the end of 2006 April and October rains. Nine stem borer resistant maize varieties were evaluated alongside six commercial checks in the moist transitional zones (East and West) at vegetative and harvest stage, while in the dry transitional zone and dry mid altitude zones, 6 new varieties were evaluated together with four commercial checks at harvest stage. Each variety was assessed on a scale of 1(very poor) to 5 (very good) based on key criteria generated in earlier group discussions with farmers and overall score. Data was analyzed using ordinal regression model of Social Package for Social Sciences (SPSS). In DT zone, Katumani, CKIR06007 and CKIR06008 were more preferred to the checks based on overall score. CKIR06008 was also more preferred on yield and tolerance to insect pest criteria, while CKIR04002, CKIR06009, and CKIR04003 were perceived more superior to local check based on tolerance to insect pests. In moist transitional zone Embu only CKIR06005 was more preferred ($p<0.01$) to the check at harvest stage in April 2006 season based on early maturity. While there was no preference for the new varieties at vegetative stage in Embu in October rains 2006 season, a number of new varieties CKIR06001, CKIR06002, CKIR06003, CKIR06004, and CKIR06005 were more preferred based on early maturity at harvest in October rains 2006 season. In the moist transitional zone (west), CKIR06005 and CKIR06005 were more preferred on maturity criteria but CKIR06004 also had good attributes in terms of cob size vegetative stage in April rains 2007. We conclude that farmers perceive some varieties to have good tolerance to insect pests in addition to good yield and maturity characteristics attributes, which are critical to the farmers in the adoption of new varieties.

Introduction

Among the insect pests attacking maize crop in Africa, the lepidopteran stem borers are by far the most injurious (Youdeowi A. 1989), due to individual damage and their diversity. Yield losses in areas with chronic borer problems vary between 10-70% (De Groote 2002). In response to the problem the stem borers, the International Maize and Wheat Improvement Centre (CIMMYT) and the Kenya Agricultural Research Institute (KARI), with financial support from the then Novartis Foundation (now Syngenta Foundation for Sustainable Development), launched the Insect Resistant Maize for Africa (IRMA) project in 1999. The project's objective is to develop adapted maize varieties with resistance against stemborers for the small scale farmers within the different agroecological zones in Kenya, using biotechnology as well as conventional breeding methods. The project enjoys a large multi-disciplinary team of collaborators, who work simultaneously on the many aspects involved: biotechnology, breeding, environment, insect resistance, impact assessment, economics, regulatory issues and public awareness.

Several instances exist where huge investments have been made to develop improved agricultural technologies that were not eventually adopted by the target population (Emad, 1995; Becker et al., 1995; Kormawa et al., 1999). Many such situations have often been associated with technologies developed using the top-bottom approach, characterized by the involvement of the target population only when the development of the technology has been finalized by scientists and would not normally involve the farmers. Many a time, the reasons for lack of adoption of the lone developed technologies by the scientists border on lack of fit into the resources (land, labor, capital, management, etc.) available to the target population and the failure to take into account the local experience and needs of the target population (Warren, 1991). Such technologies are therefore inappropriate. This explains the limited farmer adoption of technologies derived from on-station research (Wortmann, 1992; Giller et al., 1994; Becker et al., 1995). The emphasis in farmer participatory research is to enable farmers to make their own analysis and decisions based on their own perceptions and criteria. It is also important that the participatory approach also includes a double feedback: from the farmers to researchers and from the researchers to the farmers. The importance of farmer participatory research in reorienting technology development, accelerating adoption and creating wider impacts in smallholder farming has also been documented by Pretty and Hine (2001) and Johnson et al. (2003).

The objective of this paper is to demonstrate the usefulness of farmer participatory research in the evaluation of nine stem borer resistant maize varieties alongside six local checks in the moist transitional zone (east and west) and six stem borer resistant maize varieties and 4 local checks in the dry transitional zone and dry midaltutude zone. The paper would lead to the knowledge of new maize varieties that need to be further tested, multiplied, and extended to the farmers.

Methodology

Germplasm tested

The Insect tropical synthetics OPVS were developed in CIMMYT Mexico from lines with high GCA, high planting density tolerance, and resistance to the Southwestern corn borer (*Diatraea gradiosella* Dyar) and fall armyworm (*Spodoptera frugiperda* JE Smith) as described by Mugo et al., (2006). The hybrids were developed from lines from the CIMMYT multiple borer resistant (MBR) populations tested for resistance against the African stem borer (*Busseola fusca* Fuller) and *C. partellus* and other adapted inbred lines. In 2006 rains season, in Moist Transitional Zone (Embu), three OPVs (CKIR04002, CKIR04005, CKIR04006) and six hybrids (CKIR06001, CKIR06002, CKIR06003, CKIR06004, CKIR06005, CKIR06006) were tested together with the EMCO OPV and four hybrids (H513, Pannar 5243, SC Simba, PHB3253, and H614D), while in 2006 October rains season with the exception of CKIR06006, which was replaced by MBR C5B, the same new sets of new varieties were used. However, 4 new commercial checks (KSPT94, WH403, WS909 and H623) were used in addition to H513 and PHB3253. In Dry Transitional zone and Dry Mid altitude zone under the mandate of Katumani Dryland Research Centre, three OPVs namely CKIR04002, CKIR04003 and CKIR04005 and three hybrids (CKIR06007, CKIR06008 and CKIR06009)[1] were evaluated alongside local checks, Dryland Hybrid 1 (DH01), Katumani composite B, WS103, DLC1(Makueni/ DH04. Similar sets of Stem Borer Resistant materials and local checks evaluated in Embu in 2006 October rains season were use in Moist Transitional Zone (West).

[1] CKIR06008 and CKIR06009 were replaced by MBR C5 BC and KML-009 in Kiboko site

Testing sites

Evaluations were conducted in four sites in the moist transitional zone: Kaguru and Wambugu in Moist Transitional Zone (East) and Bungoma and Kakamega in Moist transitional West. Similarly, the evaluations were conducted in four sites (Kiboko, Katumani, Kambi ya mawe and Manza in the dry transitional and mid altitude zones. The evaluations were conducted at the end of the long rains season (April and October) and during the short rains season (October to February) of 2006.

Treatments and evaluations

A 5x3 alpha lattice design with three replications in two 5 m long row plots was adopted. Row spacing was 75 cm, while plant spacing was 25 cm giving a plant density of 53,000 plants ha^{-1}. Two seeds were sown per hill and later thinned down to one plant per hill. Fertilizer rates of 60 kgN and 60 kg P_2O_5 ha^{-1} were used with nitrogen being applied in two applications: at the time of planting and one month after planting. The fields were kept free of weeds by hand weeding. In April rains 2006, each of the varieties were planted in two lines. However, this was increased to 5 lines to allow farmers to have meaningful appreciation.

Group discussions were conducted to review the criteria for selection of the maize varieties at different stages of the crop growth, particularly at vegetative and harvest stage prior to the evaluations. The criteria identified as important in the selection of maize varieties were: yield, maturity, cob size, cob fill, cob diameter, grain size, and husk cover, tolerance to insect pests, tolerance to diseases, and tolerance to lodging, grain texture, and ear placement. The criteria were incorporated in a questionnaire together with information regarding socioeconomic characteristics of the households. Farmers were first asked to fill in information on socioeconomic characteristics, prior to introducing them to the objective of the evaluation. Each farmer rated the 1^{st} and 2^{nd} replications for each variety on scale of 1 (very poor) to 5 (very good) based on their criteria. An overall score for each variety was also given except in Moist Transitional Zone (west).

Data analysis

Farmer scores were ordered categorical data, for which the appropriate analysis is ordinal regression (Coe, 2002). The proportional odds regression model was used, which calculates the cumulative probabilities that a response variable Y falls in category *i* or below, for each possible *i*, where *I* refers to ordered categories. The estimate arrived at is the log odds ratio which equals to the log (odds of one treatment being high verses low/odds of another being high verses low) (Coe, 2002). The following short model was estimated:

Yj = f (Xj)

Where Y is overall farmer evaluation, score from 1-5 of treatment Xj.

Suitable checks were used in each of the maize ecologies. In the Dry Transitional and Dry midaltitude zones, DH01 was used as the check, while WH403 and H513 were used in MTZ (west) and MTZ (east) respectively.

Results and discussions

Generally most of the new stem borer resistant maize varieties were less preferred in the two seasons. However, in October rains season, at Katumani, a number of new varieties were noted with remarkable attributes based on particular criteria (Overall score, yield and tolerance to insect pests). CKIR6008 was singled out as having good attributes in terms of yield, tolerance to insect pests and on overall score. The other varieties perceived to be superior to the control, were singled out based on one criterion. CKIR06007 was perceived to be good on overall score, while CKIR06009, CKIR04002, CKIR04003 also had better qualities in terms of tolerance to insect pests than the control (Table 1).

Table 1: Appreciation based on yield and tolerance to insect pests criteria and overall score in Oct rains season 2006 at Katumani

	Overall		Yield		Pest tolerance	
Varieties	coefficient	SE	coefficient	SE	coefficient	SE
CKIR06007	0.934**	0.419	0.176	0.414	0.239	0.408
CKIR06008	0.903**	0.418	0.735*	0.419	2.101***	0.429
CKIR04002	0.615	0.417	0.264	0.415	1.245***	0.415
CKIR04003	0.343	0.416	-0.558	0.413	0.699*	0.41
CKIR06009	0.114	0.416	0.11	0.414	1.142***	0.414
CKIR04005	-0.721*	0.418	-0.872**	0.414	0.566	0.409
DH04	0.195	0.416	0.206	0.414	1.769	0.423
Katumani	0.283	0.416	-0.362	0.413	0.81	0.411
WS103	0.169	0.416	0.037	0.414	1.046	0.413
DH01	0.00	0.00	0.00	0.00	0.00	0.00
Log likelihood	138.302		141.57		154.4	
x2	22.409		22.882		33.341	

In the moist transitional zone (east), except for CKIR06005 which was more preferred ($p<0.01$) to the control at harvest in April rains 2006 on early maturity criteria, none of the other new maize varieties had better characteristics than the control (Table 2). Similarly in October rains season, CKIR06005 was more preferred to the control based on early maturity criteria. Other varieties perceived to have better early maturity qualities than the control were CKIR06001, CKIR06002, CKIR06003, and CKIR06004 (Table 3)

Table 2: Appreciation based on yield, early maturity and overall score in moist transitional zone (east) April rains 2006 season at harvest

Variety	Overall		Yield		Maturity	
	Estimate	SE	Estimate	SE	Estimate	SE
CKIR04002	-2.178	0.58	-2.437	0.6	-0.073	0.53
CKIR04005	-3.591	0.59	-2.977	0.6	-0.702	0.53
CKIR04006	-2.772	0.58	-2.723	0.6	0.187	0.532
CKIR06001	-1.06	0.58	-1.384	0.6	0.655	0.537
CKIR06002	-2.66	0.58	-2.238	0.6	-1.38	0.534
CKIR06003	-1.578	0.58	-0.91	0.5	-0.598	0.53
CKIR06004	-1.591	0.58	-1.731	0.6	0.812	0.539
CKIR06005	-1.577	0.58	-1.066	0.5	1.493***	0.557
CKIR06006	-1.422	0.58	-1.317	0.5	-0.648	0.53
EMCO	-3.57	0.59	-3.579	0.6	-0.473	0.53
Panner5243	-3.565	0.59	-2.401	0.6	-1.641	0.537
PH 3253	-2.733	0.58	-2.285	0.6	-0.801	0.53
614D	-1.864	0.58	-1.298	0.5	-1.477	0.535
SC SIMBA	-0.969	0.58	-0.379	0.5	-0.958	0.531
H513	0.00	0.00	0.00	.	0.00	0.00
log likelihood					230.026	
x2					82.468	

Table 3: Appreciation based on yield, early maturity and overall scores in moist transitional zone (east): October rains 2006 season at harvest

Varieties	Overall		Yield		Maturity	
	Estimate	SE	Estimate	SE	Estimate	SE
MBR C5 B	-0.715	0.287	-0.933	0.28	0.451	0.278
CKIR04002	-2.447	0.294	-2.609	0.29	-0.22	0.277
CKIR04005	-1.589	0.288	-2.109	0.29	0.047	0.277
CKIR04006	-0.898	0.287	-1.646	0.28	0.341	0.278
CKIR06001	-0.604	0.287	-1.356	0.28	0.472*	0.278
CKIR06002	-0.32	0.287	-0.494	0.28	0.804***	0.28
CKIR06003	-0.451	0.287	-0.692	0.28	0.581**	0.279
CKIR06004	-0.161	0.288	0.071	0.29	0.8***	0.28
CKIR06005	0.443	0.292	-0.059	0.29	1.163***	0.284
H623	-0.577	0.287	-0.681	0.28	-0.916	0.278
KSTP94	-0.523	0.288	-0.386	0.28	-0.356	0.278
PH3253	-0.226	0.289	-0.427	0.28	0.285	0.278
WH403	-0.688	0.287	-1.368	0.28	0.052	0.278
WS909	-2.074	0.291	-2.873	0.29	-0.503	0.277
H513	0.00	0.00	0.00	0.00	0.00	0.00
Log likelihood	310.274		306.53		292.321	
x2	94.557		80.466		65.919	

In Moist transitional zone (west), overall scoring was not done in both seasons and at the different stages of evaluation. However, the results of the PRAs preceding the evaluations show that yield and maturity are the most important criteria in determining choice of new maize varieties. These were consequently used in the analysis of farmer's preferences. At vegetative stage, in April rains 2006 season, CKIR06006 was more preferred on yield and maturity aspect than the control. While CKIR04006 and CKIR04002 were preferred on yield criteria, CKIR06001 was more preferred on maturity and CKIR06003 on tolerance to insect pests (Table 4).were the key criteria in the selection of maize varieties. In October rains season, CKIR06004 was more superior to the control on cob size attribute, while CKIR06005 was more superior on maturity attribute (Table 5)

Table 4: Appreciation based on yield, maturity, and tolerance to insect pests' in moist transitional zone (west) at vegetative stage, April rains 2006

Variety	Yield		Maturity		Tolerance to insect pests	
	Estimate	SE	Estimate	SE	Estimate	SE
CKIR04006	2.182***	0.708	-1.341	0.69	-0.19	0.684
CKIR04002	1.676**	0.696	-0.241	0.68	-1.251	0.695
CKIR06006	1.209*	0.688	1.393**	0.72	-0.403	0.685
CKIR06001	0.442	0.686	2.069***	0.74	0.835	0.694
CKIR06004	0.148	0.688	0.939	0.71	-0.283	0.684
CKIR06003	0.085	0.688	0.214	0.69	1.211*	0.703
CKIR04005	-0.182	0.69	0.298	0.69	0.308	0.686
CKIR06005	-0.562	0.693	-1.133	0.69	-0.622	0.687
CKIR06002	-1.621	0.7	-0.027	0.68	-1.251	0.695
WH403	0.00	0.00	0.00	0.00	0.00	0.00
Log likelihood	102.001		104.117		106.22	
X2	29.465		37.631		41.814	

Table 5: Appreciation based on maturity, cob size and pest tolerance criteria at vegetative stage, October rains 2006 Kakamega

Variety	Maturity		Cobsize		Pest tolerance	
	Estimate	SE	Estimate	SE	Estimate	SE
CKIR06004	0.978**	0.428	0.561*	0.292	0.153	0.29
CKIR06005	0.949**	0.428	0.179	0.292	0.093	0.29
CKIR04002	0.728*	0.425	-0.031	0.292	0.353	0.29
CKIR04005	0.612	0.424	-0.571	0.292	-0.109	0.29
CKIR06001	0.494	0.423	0.065	0.292	0.288	0.29
CKIR06003	0.262	0.422	-0.332	0.292	0.029	0.29
CKIR04006	0.228	0.422	-0.576	0.293	-0.077	0.29
CKIR06002	0.214	0.422	-0.365	0.292	-0.073	0.29
CKIR06006	0.116	0.421	0	0.292	-0.301	0.29
H513	0.664	0.425	-0.715	0.293	-0.24	0.29
H623	0.21	0.422	-0.73	0.293	-0.846	0.29
KSTP94	0.325	0.422	-1.154	0.295	-0.655	0.29
PH3253	0.119	0.421	1.124	0.294	0.183	0.29
WS909	-0.001	0.421	-0.271	0.292	0.353	0.29
WH403	0.00	0.00	0.00	0.00	0.00	0.00
Log likelihood	231.271		281.941			
X2	43.898		51.314			

Conclusion

Farmers perceive some varieties to have good tolerance to insect pests in addition to good yield and maturity attributes, which are critical to the farmers in the adoption of new varieties. The varieties consistently perceived to have good attributes on tolerance to pests alongside other key criteria such as yield and early maturity need to be further tested, multiplied, and extended to the farmers for increased maize productivity.

References

Becker M, Ladha JK, Ali M (1995). Green manure technology: potential, usage, and limitations: A case study for lowland rice. Plant Soil 174: 181–194.

Emad A (1995). An assessment of the impact of agricultural technology on output in the rainfed farming areas in Jordan. Arbeiten zur Agrarwirtschaft in Entwictlunslanderern,Wissenschaftsverlag Vaul Kiel KG, Dissertation, veroffentlicht mitGenehmigung der Agrarwissenschaftlichen Fakultaet der Christian-Albrechts-Universitaet, Kiel, Germany.

Giller KE, McDonagh JF, Cadisch G (1994). Can biological nitrogen fixation sustain agriculture in the tropics? In Soil Science and Sustainable Land Management in the Tropics. Eds. J.K. Syers and D.L.Dimmer. University of Newcastle upon Tyne, UK. pp 173–191

H. De Groote 2002. Maize Yield Losses from Stem borers in Kenya. Insect Science and its Application 22:89-96.

Johnson N, Lilja N, Ashby J (2003). Measuring the impact of user participation in agricultural and natural resource management research. Agric. Syst. 78: 287–306.

Kormawa PM, Kamara AY, Jutzi SC, Sanginga N (1999). Economic evaluation of using mulch from multipurpose trees in maize-based production systems in south-western Nigeria. Exp. Agric. 35: 101–109.

Mugo S; Oyoo M., Bergvinson D., DeGroote H., and Songa J. 2006. Evaluation of Open Pollinated Maize Varieties for Resistance to Chilo Partellus in Dryland Mid-Altitudes and Coastal Lowlands of Kenya. To be published as proceedings of the 10th KARI Biennial Scientific Conference 12-17 November 2006, KARI Headquarters Nairobi Kenya.

Pretty J, Hine R (2001). Reducing food poverty with sustainable agriculture: a summary of new evidence. Final report from the SAFE World Research Project. University of Essex, Cochester, UK.

Wortmann CS (1992). Agriculture technology evaluation – some considerations. In: Proceedings of a Working Group Meeting on Soil Fertility Research for Maize and Bean Production Systems of the Eastern Africa Highlands. 1 – 4 September, Thika, Kenya. pp 49–58

Youdeowi A. 1989. Major arthropod pests of food and industrial crops of Africa and their economic importance. In Biological Control: A Sustainable Solution to Crop Pest Problems in Africa, ed. JS Yanninek, HR Herren, pp. 51–60. Ibadan, Nigeria: Int. Inst. Trop. Agric. 210 pp.