

Review

Maize research and production in Nigeria

Iken, J.E.* and Amusa, N.A.

Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, PMB 5029, Moor Plantation, Ibadan. Nigeria.

Accepted 16 August 2011

Maize (*Zea mays*) is a major important cereal being cultivated in the rainforest and the derived Savannah zones of Nigeria. Land races, improved high yielding and pest and diseases resistant varieties of maize have been developed.

Key words: Maize, *Zea mays*, Nigeria.

HISTORICAL PERSPECTIVES

Most of the work done on maize prior to 1950 can be described as agronomic. Research on methods of cultivating maize was to a large extent secondary since the designing of efficient farming system was given priority. Maize was used merely as a test crop for soil fertility to determine the influence of green manures and various sequences of crops in the rotation. Most of this work was done at Moor Plantation in Ibadan, Ogbu near Benin City and Umudike near Umuahia.

Maize has been in the diet of Nigerian's for centuries. It started as a subsistence crop and has gradually become more important crop. Maize has now risen to a commercial crop on which many agro-based industries depend on as raw materials.

The first attempt at Agricultural research in Nigeria was made in 1899 (Fakorede et al., 1993). Initial Agricultural research work in Nigeria was directed at promoting the development of various cash crops including cocoa, oil palm, cotton, groundnut for export purposes. The advent of a very destructive rust disease known as the American rust, incited by *Puccinia polestar*, which entered West Africa in 1950, called attention to the importance of maize as food crop.

The absence of resistance or tolerance in the local maize varieties to the American rust shaped the first approach towards an improvement of the maize crop and introduction of maize materials from all over the world. Subsequently, organized approach towards a systematic

study of the crop was established at the Federal Department of Agricultural Research (FDAR) Moor Plantation, Ibadan in 1956. This initial approach was to breed for disease resistance. The screening of local and introduced varieties was the first step towards the recognition of promising maize materials.

This first step was followed immediately by selection work, which served to improve the adaptability and the suitability of the new varieties.

The idea of breeding for resistance to multiple diseases was initiated from the early years of maize breeding in Nigeria. Varieties having multiple disease resistance became available with time; for example NCBRbU (Nigeria composite B) with combined resistance to rust (R) and blight (B) and an upright leaf orientation (U) (Fakorede et al., 1993).

In 1961, some maize varieties were artificially inoculated to test for their quantitative reaction to the Polestar rust under field conditions (Craig, 1962). A total of 137 maize cultivars were screened over a period of three years for resistance to polestar rust, maize blight, Curvularia leaf spot, streak virus and brown leaf spot (Fajemisin, 1978). All the entries exposed to streak had 70% disease incidence. Next to streak, rust appeared to be the most destructive of the diseases, followed by Curvularia leaf spot.

The important diseases have changed with time. Streak virus that was relatively unimportant up to about 1970 is now easily the most devastating disease of maize nationwide. Downy mildew that was unknown in the early stages of maize improvement came "on the stage" in 1975 in some specific zones and is now the most deadly

*Corresponding author. E-mail: naamusa@softhome.net.

constraint to maize production in the endemic zones. Resistance to both downy mildew and streak had been bred into maize – (DMRSR Varieties) through the effort of research institutions in Nigeria. These varieties produced more than 3t/ha under severe downy mildew pressure during which susceptible varieties gave very low yield of about one tonne per hectare (Fakorede et al., 1993).

GERMPLASM COLLECTION

A systematic collection and evaluation of locally available maize germplasm was initiated in 1953. Staton (1954) grew all the collected germplasm at Moor Plantation, Ibadan and suggested a maize type distribution on the basis of bran characteristics only. Van Eijnathen (1965) included color of grain, teaseling time, number of kernel rows per ear and plant height to group the cultivated varieties into four distinct classes as follows:

- (1) Western flourey types – White grain – often showing some flintiness in the endosperm, relatively early maturing, of medium height with ears having up to 16 kernel rows.
- (2) Eastern flourey types – White flourey grains – larger in size than Western flourey types. Red and blue grains commonly available; medium to late maturity, medium height; less than 16 kernel rows.
- (3) Southern flint – predominantly yellow flinty types; with medium to late maturity, plants are usually tall (over 2m) about 12 kernel rows.
- (4) Northern flints – Predominately yellow flint types, white types often round, medium maturity and medium height about 16 kernel rows.

Germplasm collection (see Table 1) is very much a part of maize improvement activities in Nigeria. Alike and Aken'ova (1986) embarked on a systematic collection of local maize in the then Bendel State to determine the degree of genetic relationship among the different types and investigate the existence of valuable agronomic traits that could make them sources of useful genes. An interesting observation made was that the different color types tended to exist in specific areas of the state – creamy yellow accessions were found in the South, while the white was found in the middle to the more northerly derived Savanna regions. All the yellow types were flint while the white types were either flint, flourey or flint dent.

Although maize is increasingly being utilized for livestock feed, it is still a very important staple food for millions of Nigerians. In order to satisfy specific consumer preferences, the varieties developed are varied in grain color (mainly white and yellow) and endosperm characteristics (dent, flint, flourey and varying grades between the three) . Flint maize is relished as green maize whereas the dent varieties have starch content preferably with minimal chaff and therefore suitable for food dishes such as “ogi, akamu, and tuwo. White grain

varieties are preferred for this purpose. Yellow maize varieties are increasingly being requested for producing livestock feed in order to impart yellow color on the egg yolk.

Popcorn has been a cherished snack in Nigeria for several decades. The Nupe popcorn women hawkers have been most popular in the south-westerns part of the country for many yeas. Demand for popcorn increased very sharply from the mid- seventies resulting in large-scale roadside vending in big town and cities. This was possible due to the introduction popping technology.

Institute of Agricultural Research and Training (IAR&T) and National Crop Research Institute (NCRI) have mandate for popcorn variety development in Nigeria, the "IAR&T popcorn" was synthesized from a supermarket sample which has a in popping quality, but very susceptible to foliar diseases such as rust, blight and streak. Selecting against extreme susceptible to rust and blight, IAR&T has developed "white pop" which is taller, later maturing, less susceptible to rust and blight and significantly higher in yield but with slightly lower popping expansion. Recently, two popcorn varieties (Ashland pop and yellow composite) have been recommended for on farm testing and eventual release to farmers.

There is a great variation among different strains of maize in the content of protein and fat. The Water free portion of the kernel contains about 77 percent starch, 2 percent sugar, 9 percent protein, 5 percent pentosan, 2 percent ash and 5 percent fat. The proportion of protein may be as high as 15 percent and as low as 6 percent. In the maize kernel about 80 percent of the protein is in the endosperm. The germ, though constituting only about 10% of the grain, contains about 20% the total protein (Iken et al., 2002). The protein has low contents of 2 essential amino acids, lysine and tryptophan, needed for growth by young animals namely. The main approach in improving the nutritive value of maize has been through addition of legume (Ashaye et al., 2000; Omueti, 1999). Recently Maize breeders in IAR&T had successfully bred maize varieties with high lysine and tryptophan content.

MAIZE PRODUCTION

Maize improvement work started in the forest zones but yield trials were soon conducted in both forest and savanna locations (Van Eijnatten, 1965). The evaluation zones were:

1. Wet rainforest, covering most of Eastern States of Nigeria and the South-Western part.
2. Derived Savanna, fringing the forests and forming the transition to the southern Guinea Savanna.
3. Southern Guinea Savanna.

Because of the differences in yield potential of the ecological zones, testing of new maize varieties across

Table 1. Maize varieties available for cultivation in Nigeria.

NO	VARIETY NAME	GRAIN TYPE	MAJOR STRENGTH	MAJOR WEAKNESS	RECOMMENDED TARGET AREA/SEASON
1.	WESTERN YELLOW NARZO – 17 NEW (FARZ 7) OLD	Y.SF	High yielding widely adapted	Tall, susceptible	First season planting only. Forest ecology only
2.	096EP6 NARZO – 18 (FARZ – 23)	Y.F.	Fairly high yielding prolific	Fall, susceptible to streak and downy mildew	First season planting only. Forest ecology only
3.	TZPBSR NARZO – 30 New (FARZ 27) old	W1D	High yielding widely adapted streak resistant	Susceptible to downy mildew	Early season planting across the country
4.	TZBSR NARZO 29-New (FARZO – 34) old	W1SF	High yielding, widely adapted Streak resistant	Susceptible to downy mildew	Early season planting across the country
5.	TZSR-W-1 NARZO-20	W1SF	High yielding, widely adapted Streak resistant	Susceptible to downy mildew	Country wide
6.	TZESR – 20	W/Y	Fairly high yielding	Susceptible to downy mildew	Country wide
7.	EV9043SR	W1D	Fairly high yielding	Susceptible to downy mildew	Country wide
8.	DMR – LSRW	W1SD	Late Fairly high yielding resistant to both streak and down mildew	None	Downy mildew affected zones
9.	DMR-LSR-Y	Y1SD	Late, -do-	None	Downy mildew affected zones
10.	TZMSR-W	W1D	Late. High yielding resistant to streak high land rust and blight	None	High land areas (over 100m above sea level)
11.	Kewesoke	W1F	Inter. Upright leaves. Suitable for intercropping	Susceptible to steak and downy mildew, low yield	Intercropping

the country became an established practice in maize breeding. These trials were called cooperative maize yield trials (Chinwuba, 1962). With time, the name has gone through several changes, including zonal Trials, Uniform maize, variety trials and now, Nationally Coordinated Maize Variety Trials (NCMVT).

Yields in Ibadan (7°22'N) representing the Forest zone and Mokwa (9°19'N) in the Southern Guinea Savanna were much lower than in Savanna (11° 11'N) of the Northern Guinea Savanna. A comparison by Fakorede et al. (1989b) of Forest and Savanna location since yield trials conducted for four years showed that the yield advantage of the savanna was due primarily to ear number. Whereas number of plants harvested was about the same in the two agro-ecologies, the savanna zone consistently produced more ears per unit land area. Therefore barrenness was much more pronounced in Forest zone than in Savanna ecologies. Maize plants in the savanna were taller with higher ear placement, suggesting greater vigor of growth. Number of days to

silking was about the same in the two ecologies although the late Ops and the yellow hybrids tended to silk later in the Savanna than in the forest zone. However, percentage moisture content at harvest was consistently lower at savanna than at forest locations. This implies a shorter grain – filling duration and/or a faster dry-down rate in the savanna than in forest ecologies. Indeed, the “stay green” character secures frequently in the forest zone, whereas it is almost non-existent in the savanna zones.

The hybrid maize project has made an impact in Nigeria. The yield advantages of hybrids appear to be sufficiently large to attract the attention of farmers. Improved high yielding maize variety can express its full genetic potential only when offered optimum management resources. This starts with the right choice of site through timely and appropriate establishment, nutrition, disease and pest control to proper harvesting procedure and produce disposal and/or storage. Details of these operations with regards to maize production

technology relevant to Nigeria are:

Land clearing and yield preparation: Land clearing must be carried out with minimal displacement of the topsoil. It requires judicious use of heavy machinery coupled with sound soil conservation measures that will preserve the soil fertility status, which varies under long-term fallow vegetation. Minimum tillage is a feasible way of sustaining high soil fertility under intensive maize farming.

Planting time: Sowing date is an essential component of crop management. Yields decline with lateness of planting after an optimum time, usually the start of the rains. Response of varieties to other inputs is dependent upon planting time. Optimum planting in each of the major agro-ecological zones of Nigeria falls with these following ranges:

1. Forest zone – Mid April – 2nd week in May
2. Forest – Savanna transition – 3rd week in April – 3rd week in May
3. South Guinea Savanna Last week in April – 3rd week in May.
4. Northern Guinea Savanna – last week in May – 1st week in June
5. Sudan Savanna – First 2 weeks in June

Plant population: An optimum plant population is essential for maximum yield in maize. Farmers grow maize at very irregular and wide spacing, due to the fact that most farmers inter-crop maize with other crops. A direct relationship between plant population and final yield to some extent, is obvious because total grain yield is positively and significantly correlated with the number of ears and hence with the number of harvestable plants. A plant population of 53,333 plants/ha is recommended. This is obtainable with a 75 cm x 50 cm spacing at 2 plants per hill or a 75 cm x 25 cm spacing at 1 plant per hill. Farmers are known to prefer wide spacing so as to afford easy movement for weeding and other operations.

Plant nutrients and Fertilizer applications: For good growth and high yield, the maize plant must be supplied with adequate nutrients particularly nitrogen, phosphorus and potassium. The quantity required of these nutrients particularly nitrogen depends on the pre clearing vegetation, organic matter content, tillage method and light intensity (Kang, 1981). The most important of these micronutrients for maize growth are sulphur, zinc and magnesium particularly in the savanna and under continuous cropping of maize in the Forest ecology. The nutrient requirement is satisfied by the application of the right form of fertilizer containing the requisite combination of the elements.

Weed Control: Weeds cause severe yield reduction in

maize in Nigeria because they compete with the crop for nutrients; water and light. Weed control is the most expensive operation in traditional maize farming since it is procured manually. Often, the labour is too expensive causing many farmers to abandon weed control thereby resulting in very low yields.

Disease Control: Although several diseases have been identified on maize in Nigeria (Fajemisin et al., 1976; Oladipo et al., 1993), only few of them significantly reduce maize yields. They are maize rust, leaf blight, maize streak, downy mildew, maize mottle/chlorotic stunt, Curvularia leaf spot, stalk and ear rots. In order to make maize farming economically feasible, resistant lines were bred (Van Eijnatten, 1963; Fajemisin et al., 1978; Efron et al., 1989) and made available to farmers. With these efforts, maize streak, smut and rust have been kept under control.

Downy mildew disease of maize was first reported in Nigeria in 1969 in Samara near Zaira Kaduna State. However, in 1995, over 75000 square kilometers was affected within the forest and transitional forest zones of Nigeria. (Adenola et al., 1995). From 1970 to 1995 only one species of *Peronosclerospora* was known in Nigeria, and two pathotypes of this pathogen. However, due to series of studies on the etiology, epidemiology of the pathogen, another *Peronosclerospora* has been observed in maize together with *P. sorghi* (Adenle and Cardwell, 1999)

Most of maize varieties grown in Nigeria are highly susceptible to downy mildew disease. Fortunately, genes for resistance have been identified from maize germplasms in Thailand and the Philippines, where downy mildew is the most serious disease of maize. Genes for downy mildew resistance has been incorporate into streak resistant varieties (Fajemisin et al., 1985). Scientists in Nigeria have developed high-yielding disease resistant/tolerant maize varieties. The newly developed varieties of maize has between 90 and 95% resistance to the pathogen without extra fungicide protection

Recently, a maize parasitic weed called striga is causing economic loss in Northern Guinea Savanna and some parts of derived Southern Guinea (Ogunbodede and Olakojo, 2001). *Striga hermonthica* is a threat to increased maize production in Nigeria particularly in the high – yield potential savanna zone. Scientists have identified some inbreeds and hybrids that have consistently demonstrated tolerance to *S. hermonthica* under heavy infestation (Kim et al., 1984; Olakojo and Kogbe, 1999; Ogunbodede and Olakojo, 2001). Olakojo et al. (2001) also reported that the use of NPK and urea fertilizers as effective means of controlling *S. hermonthica* in maize field.

Insect Pest Control: Stem borers, armyworms, silkworms, grasshoppers, termites and weevils are the

economically important insect pests of maize in Nigeria (Daramola, 1991). These pests are grouped into three categories (i) the field pests (ii) the field to-to-store pest and (iii) store pests. Use of chemicals (insecticides) is presently the most popular control measure in Nigeria (Daramola, 1985 a,b; Daramola, 1991). But these chemicals are very expensive and are not easily available. However, synthetic insecticides possess the capacity to leave harmful residues in food commodities if used incorrectly, as well as the ability to give rise to a rapid emergence of resistant strains. There has been a renewed interest in the use of natural plant products in the protection of stored agricultural products against insect pests in storage (Don-Pedro 1989, 1990; Lale 1992, 1994) . The use of plant products in form of powders in the management of stored products Coleopteran is the most convenient, the powders are easy to apply, and the commodities remain clean after treatments. Moreover, the moisture contents of the commodities are not increased. Powders of some species of plants have been used successfully for the control of different species of stored product pests (Ivbijaro, 1983; Ivbijaro and Agbaje, 1986; Lale, 1992, 1993.). Research is also continuing in the search for genetic resistance to stem borer and other insect pests of maize.

TREND IN MAIZE PRODUCTION

Until recent years, the bulk of maize grain produced in Nigeria was from the southwest zone. Ogunbodede (1999) reported that western Nigeria generally produced about 50% of Nigeria green maize, the remaining 50% being split between the North and the east. Although large proportion of the green maize is still produce of the south- Western part, there has been a dramatic shift of dry grain production to the savanna, especially the Northern Guinea savanna. This can now be regarded as the maize belt of Nigeria. In this zone, farmers tend to prefer maize cultivation to sorghum. This trend may have been brought about for several seasons including availability of streak resistant varieties for all ecological zones in Nigeria, availability of high-yielding hybrid varieties, increase in maize demand coupled with the federal Government imposed ban on importation of rice, maize and wheat. Local production had to be geared up to meet the demand for direct human consumption, breweries, pharmaceutical companies, baby cereals, livestock feeds and other industries.

Seed production and certification have taken a new turn in Nigeria with the establishment of private seed companies. The National seed service that used to be the primary source of improved seed also expanded its facilities, widened its scope and hired better trained staff. Thus, improved seeds are readily available to farmers. Maize is most productive in the middle and Northern belts

of Nigeria, where sunshine is adequate and rainfall is moderate (Obi, 1991). Under these conditions, storage of grains can be accomplished without much damage from insect pests. The recent achievements by breeders in the development and release of superior maize varieties with higher yield potentials and better resistance to insect pests and diseases has played a central role in increase maize production in the country (Obi, 1992).

REFERENCES

- Adenle VO, Cardwell KF (1999). A new strain of downy mildew pathogen of Maize: A challenge to Geneticists/ breeders Genetics in food security in Nigeria 54-55.
- Alika JE, Aken'ova. ME (1986). Preliminary investigation into the variation between local maize (*Zea mays* L.) germplasm of Bendel State of Nigeria. Proc. Of Nationwide Conference on Maize Research, Production and Utilization in Nigeria, Progress and Problems. Univ. of Ife, Ile-Ife Nigeria. March, 17-21.
- Adenola OA, Akinwumi JA (1993). Maize production constraints in Nigeria. Fakorede et al. editors) Maize Improvement, Production and utilization in Nigeria published by the maize association of Nigeria, pp. 223-232.
- Ashaye OA, Fasoyiro, SB, Kehinde RO (2000). Effects of processing on the chemical and Sensory Quality of Ogi Fortified with Full Fat Cowpea Flour. Moor Journal of Agricultural Research 1: 115-123.
- Chinwuba PM (1962). Report on cooperative maize yield trials carried out in Nigeria during 1960 and 1961 Western Nigeria Ministry of Agriculture and National Resources, Ibadan.
- Craig J (1962). In Annual Reports of the USAID-ARS Project on Major Cereal in Africa.
- Daramola AM (1985a). Comparative effectiveness of Carbofuran and Carbaryl for the control of maize stem borers. Niger. J. Plant Protect. 9: 54-59.
- Daramola AM (1985b) Field evaluation of the resistance of nine maize cultivars to stem borers. Niger. J. Sci. 20 41-44
- Don-Pedro KN (1989) Effects of fixed vegetative oil on oviposition and adult mortality of *Callosobruchus maculatus* (F) on cowpea. International Pest Control 31: 34-37.
- Don-Pedro KN (1990) Insecticidal activities of fatty acid constituents of fixed vegetable oils against *Callosobruchus maculatus* (F) on cowpea. Pesticide Sci. 30, 295-302.
- Efron YSK, Kim JM , Fajemisin JH, Mareck CY, Tang Z I, Daborowski HW, Thottappilly G. (1989).Breeding for resistance to maize streak virus: A multidisciplinary team approach. Plant Breed. 103:1-36.
- Fajemisin JM, Denton L, Ago CE (1976). Search for improved maize varieties for farmers in Nigeria Progress and Problems presented at the 3rd National Workshop of Rice/Maize Center, NAFPP. Ibadan, Dec.6-10 1976.
- Fajemisin JM (1978). Evaluation of 137 maize cultivars for resistance to Polysora rust leaf blight, curvularia leaf spot, streak and Physoderma brown spot. Research Bulletins No.6 N.C.R.I Ibadan.
- Fajemisin JM (1985). Maize diseases in Africa and their role in varietal improvement process. Proceedings of the 1st Eastern, Central and southern African Regional Maize Workshop held in Lusaka, Kenya March 10-17.
- Fakorede MAB, Kim SK, Mareck JH, Iken JE (1989). Breeding Strategies and Potentials of available varieties in relation to attaining self-sufficiency in maize production in Nigeria. Presented at the National Symposium "Towards the attainment of Self-Sufficiency of Maize Production in Nigeria 9 March, 1991 I.A.R.& T., Ibadan.
- Fakorede MAB, Fajemisin JM, Kim SK, Iken JE (1993). Maize improvement in Nigeria. In MAB Fakorede et al. (Eds) Maize improvements, production and Utilization in Nigeria, pp. 15-39.
- Iken JE, Amusa NA, Obatolu VO (2002). Nutrient composition and weight evaluation of some newly developed maize varieties in Nigeria. J. Food Tech. Africa (Kenya) 7:25-28.

- Ivbijaro MF (1983). Toxicity of neem seed, *Azadirachta indica* A.Juss to *Sitophilus oryzae*(L) in stored maize. *Protect. Ecol.* 5:353-357.
- Ivbijaro MF, Agbaje M (1986). Insecticidal activities of *Piper guineense* schum and T Thonn and *Capsicum* species on the cowpea bruchid, *Callosobruchus maculatus*. *F. Insect Sci. Appl.* 7: 521-524.
- Kang BT (1981). Nutrient requirement and fertilizer use for maize. In *Agronomy training manual for agroservice agronomist NAFPP/IITA*. Fed. Dept. Agr. Lagos, pp. 405-416.
- Kim SK, Khadhar V, Parkinson JM, Fajemisin Efron Y (1984). Breeding maize for field resistance to striga in Africa. Presented at the 76th Ann. Conf. Amer.Soc Agron. Nov. 25-30 1984 Lag Vegas, Nevada U.S.A.
- Obi IU (1991). Maize: Its agronomy, diseases, pests and food values optimal computer solutions limited, Enugu 208 p.
- Oladipo JL, Fajemisin JM, Olanya O (1993). Disease of maize- Damage and control in Nigeria. Maize improvements, production and Utilization in Nigeria, pp. 1181-1188.
- Olakojo SA, Kogbe JO (1999). Reaction of some maize Genotypes with infestation with *Striga asiatica*. *Bioscience Research Communication* 131S-139S.
- Omueti O (1999). Home level preparation of protein improved kokoro (soya-kokoro maize snack). *Tropical oil Seeds Journal* 4: 95-101.
- Ogunbodede BA, Olakojo SA (2001). Development of *Striga asiatica* tolerant hybrid maize (*Zea mays* L.) varieties: *Tropical Agriculture Research and Extension* 4(1): 2001
- Olakojo SA, Kogbe JOS, Olajide V, Doh Nell A (2001). Host-Parasite relationship of *Striga asiatica* and maize (*Zea mays*) under varied moisture levels and Nitrogen source. *Nigeria Journal of Weed Science* 14: 41-46.
- Lale NES (1992). Oviposition-deterrent and repellent effects of products from dry chili pepper fruits, *Capsicum* species of *Callosobruchus maculatus*. *Post-harvest Biology and Technology* 1: 343-348.
- Lale NES. (1993) A laboratory assessment of the effectiveness of four storage devices and *Capsicum frutescens* in the abatement of infestation of stored cowpeas by *Callosobruchus maculatus* (coleoptera: Bruchidae). *Revue de Zoologie Africaine* 107: 39-43.
- Lale NES. (1994) Laboratory assesment of the effectiveness and persistence of the powder of four spices on bruchuid and maize in air-tight storage facilities. *Samaru Journal of Agricultural Research* 11: 79-84.
- Staton WR (1954). Progress report on a maize survey of West Africa. *Reports of West African Maize Research Unit*.
- Van Eijnathen LM (1965). Towards the improvement of maize in Nigeria. Ph.D. Thesis. Wageningen, The Netherlands.