Agronomic potential of "Dodzi", an extra early-maturing maize cultivar

P. Y. K. SALLAH, K. OBENG-ANTWI, S. TWUMASI-AFRIYIE, E. A. ASIEDU, K. BOA-AMPONSEM, K. AHENKORA & A. AGYEMANG
CSIR-Crops Research Institute, P. O. Box 3785, Kumasi, Ghana

ABSTRACT

Production of short-cycle crop varieties reduces the risk of crop loss due to terminal droughts and ensures early harvest to fill the hunger gap. Two experiments were used to determine the yield potentials of elite extra-early (75-80 days) maturing maize (*Zea mays* L.) varieties to recommend the best extra-early variety for commercial production and use in Ghana. In the first experiment, two extra-early and eight early (90-95 days) maize varieties were evaluated in replicated field trials at 10 research stations in 1995 and 1996. In the second experiment, the two extra-early varieties, one recommended early variety, and the farmers' check variety were evaluated at 38 and 28 farm sites in 1995 and 1996, respectively. Mean grain yields across the 10 on-station sites in 2 years were 3.5, 4.1, 4.6, and 3.4 t ha^{-1} for NAES EE W-SR (extra-early), NAES Pool 16 DT (extra-early), Dorke SR (early), and the farmers' check variety, respectively. Mean yields of the four varieties across 66 farm sites in both years were 3.2, 3.4, 3.4, and 3.6 t ha^{-1}, respectively. NAES EE W-SR was the earliest of all the varieties tested and the farmers' variety was latest. Food preference tests showed that NAES EE W-SR was comparable to the farmers' check variety in suitability for local dish preparations. The National Variety Release Committee subsequently approved and released NAES EE W-SR under the local name "Dodzi". "Dodzi" is recommended for early planting and harvesting throughout Ghana.

NARS edition; revised 09 Aug 06.

RÉSUMÉ

SALLAH, P. Y. K., OBENG-ANTWI, K., TWUMASI-AFRIYIE, S., ASIEDU, E. A., BOA-AMPONSEM, K., AHENKORA, K. & AGYEMANG, A. : *Potentiel agronomique d' une variété de maïs à maturation extra-précoce, "Dodzi"*. La production de variétés de culture à cycle court reduit le risque de perte de culture provoqué par la sècheresse terminal et assure la moisson précoce pour combler les différencesede la faim. Deux expériences étaient menées pour déterminer les potentiels de rendement des variétés du maïs (*Zea mays* L.) à maturation élite extra-précoce (75-80 jours) en vue de recommander la meilleure variété extra-précoce pour la production commerciale et utilisation au Ghana. Dans la première expérience, deux extra-précoces et huit précoces (90-95 jours) de variétés de maïs étaient évaluées dans les champs d' essai répliqués à 10 stations de recherche en 1995 et en 1996. Dans la seconde expérience, les deux variétés extra-précoces, l'une des variétés précoces recommandés et une variété de contrôle d'agriculteurs étaient évaluées à 38 et 28 sites de champs respectivement en 1995 et 1996. Les rendements de grain moyen à travers les 10 sites à la station en deux ans étaient 3.5, 4.1, 4.6 et 3.4 t ha^{-1} pour NAES EE W-SR (extra-précoce) NAES Pool 16 DT (extra-précoce), Dorke SR (précoce), et respectivement pour la variété de contrôle d'agriculteurs. Les rendements moyens des quatre variétés à travers 66 sites de champs pendant les deux années étaient respectivement 3.2, 3.4, 3.4 et 3.6 t ha^{-1}. NAES EE W-SR était le plus précoce de tous les variétés mises à l'essai et la variété d'agriculteurs était la plus tardive. Les tests d' alimentation préférée montraient que NAES EE W-SR était comparable à la variété de contrôle d'agriculteurs en ce qui concerne la qualité d' être convenable pour les préparations de plat local. La Comité Nationale pour la Sortie de Variété a approuvé et elle a fait la sortie de NAES EE W-SR sous le nom local "Dodzi". "Dodzi" est recommandé pour la plantation et la moisson dans le Ghana entier.

Introduction

Maize is an important staple crop under rain-fed agriculture in the forest, forest-savanna transition, coastal, Guinea and Sudan savanna zones of Ghana. To meet the varietal needs of growers in these agro-ecologies, the Crops Research Institute (CRI) released several maize varieties belonging to early, intermediate, and late maturity groups for commercial production in the country (Sallah *et al*., 1993; Badu-Apraku *et al*., 1990, 1992; Twumasi-Afriyie *et al*., 1992). Early varieties mature in 90-95 days, intermediate types in 105-110 days, and late (full-season) varieties mature in 115 to 120 days after planting. The CRI-bred varieties have been widely adopted by maize farmers in the country (GGDP,1991; Dankyi, Anchirinah & Apau, 1997).

Yield loss due to terminal drought is one of the major constraints to maize production in Ghana (Kasei, Mercer-Quarshie & Sallah, 1997; Ohemeng-Dapaah, 1994; SARI, 1995; Mercer-Quarshie *et al.*, 1993). At annual planning workshops, farmers often suggested the development of early-maturing varieties as one of the solutions to the drought problem. Farmers have also shown interest in earlier-maturing varieties to ensure early harvest as green maize, and also as grain to fill the hunger gap that occurs annually before the main harvest. Based on these considerations, the CRI maize breeding programme embarked on developing extra-early maize varieties in 1990.

Extra-early maize varieties reach maturity in 75-80 days after planting. Extra-early populations were developed from crosses involving extra-early maize introductions, and improved early germplasm by SAFGRAD (Semi-Arid Food Grain Development Project) were improved for extra-earliness, high yield potential, and resistance to the maize streak virus disease through the WECAMAN (Maize Network for West and Central Africa) Project. Extra-early maize varieties were tested in the Guinea and Sudan savanna zones of Ghana from 1991 to 1994 (WECAMAN, 1992, 1993, 1994, 1995).

This investigation was undertaken to (i) determine the yield potentials of the elite extra-early varieties in the major agro-ecological zones of Ghana, and (ii) identify the best extra-early variety for release to farmers.

Materials and methods

Agronomic evaluations of extra-early varieties

Two extra-early and eight early-maturing varieties, including the farmer's variety, were evaluated at established research fields at Pokuase and Ohawu (coastal savanna), Fumesua (forest), Ejura and Kpeve (transition), Damongo (woodland savanna), Nyankpala and Wa (Guinea savanna), and Manga (Sudan savanna) in 1995 and 1996. In addition, four varieties comprising two extra-early varieties, Dorke SR, and the farmer's variety, were evaluated in farmers' fields in the coastal savanna, forest, transition and Guinea savanna zones in both years. The on-farm trials were conducted in collaboration with the Ministry of Food and Agriculture in all the agro-ecological zones.

In the on-station evaluations, a randomized complete block design with four replications per location was used at each site. A plot consisted of four 5-m rows of each variety at 66,000 plants ha^{-1} density in the interior savanna locations and at 62,000 plants ha^{-1} in the coastal savanna, forest, transition, and Guinea and Sudan savanna zones. In the interior savanna, planting was either on ridges or on the flat; where planting was on the flat, ridging was applied after seedling establishment. Planting was on the flat under zero-tillage in the coastal savanna, forest, and transition sites. Pre-emergence chemical weed control was used and consisted of applying a combination of pendimethalin (Stomp) and gesaprim at 1.5 and 1.0 1 ha^{-1} a.i., respectively, at planting. Where there was lush vegetation before planting, paraquat was applied at 1.0 l ha^{-1}a.i. in addition to pendimethalin and gesaprim. In zero-tilled fields, glyphosate (Round-up) was applied at 1.5 l ha^{-1} a.i. 2 weeks before planting. Hand weeding was applied, when necessary, to keep plots free of weeds.

In the on-farm evaluations, an RCBD with one replication per site (farm) was used in the 2 years.

A plot consisted of eight 5-m rows of each variety. Row spacing was 0.75 m and hills within-row were spaced at 35 cm for NAES EE W-SR and NAES Pool 16 DT (both extra-early) and at 40 cm for Dorke SR and the farmer's variety. Three seeds were planted per hill and thinned to two plants per hill at establishment, giving a target population of 76,000 plants ha^{-1} for the extra-early varieties and 66,000 plants ha^{-1} for Dorke SR and the farmer's variety. Fertilizer and seed for the trials were provided to all participating farmers. Each farmer was responsible for the initial land preparation, weed control and general management of the trials. Farmers participated in applying fertilizer and harvesting. In the on-farm and on-station evaluations, fertilization was by spot-application of 45 kg N ha^{-1} and 45 kg P_2O_5 ha^{-1} at 8-10 days after planting at all sites. Additional 45 kg N ha^{-1} was side-dressed using urea or sulphate of ammonia at 3-4 weeks after planting.

Data were recorded from the two middle rows of the plot of each variety in the on-station trials and from the four middle rows of a plot in the on-farm evaluations. Traits considered were grain yield at 15 per cent moisture, days to 50 per cent silk emergence, plant height, total lodging, ear acceptability rating, and MSV disease reaction. The data were analysed by location and combined over locations (Steel & Torrie, 1980).

Sensory evaluation of extra-early varieties in local foods

Seven maize varieties, comprising NAES EE W-SR, GH 110-5, GH132-28, GH2328-88, Obatanpa, Dorke SR, and the local variety, were processed into three local dishes "Tuo zaafi", "Ga" and "Fanti kenkey". "Tuo zaafi" was prepared by the staff of WIAD/MOFA, Tamale. The maize was also processed into "kenkey" by the staff of WIAD/MOFA, Kumasi, and by commercial "kenkey" producers. Twenty sensory evaluation panelists, comprising local dish vendors and consumers, evaluated the varieties for their suitability in the local dishes in Tamale and Kumasi. Panelists rated the samples for overall acceptability by how much they liked or disliked each sample. The rating was converted to scores on a 7-point hedonic scale with a score of 7 signifying 'like very much', 6 signifying 'like moderately', 5 signifying 'like slightly', 4 signifying 'neither like nor dislike', 3 signifying 'dislike slightly', 2 signifying 'dislike moderately', and 1 signifying 'dislike very much' (Larmond, 1977). Data were analysed using ANOVA, and Duncan's Multiple Range Test was applied to determine the significance between sample means (Steel & Torrie, 1980).

Results and discussion

Fig. 1 presents grain yield data on the extra-early

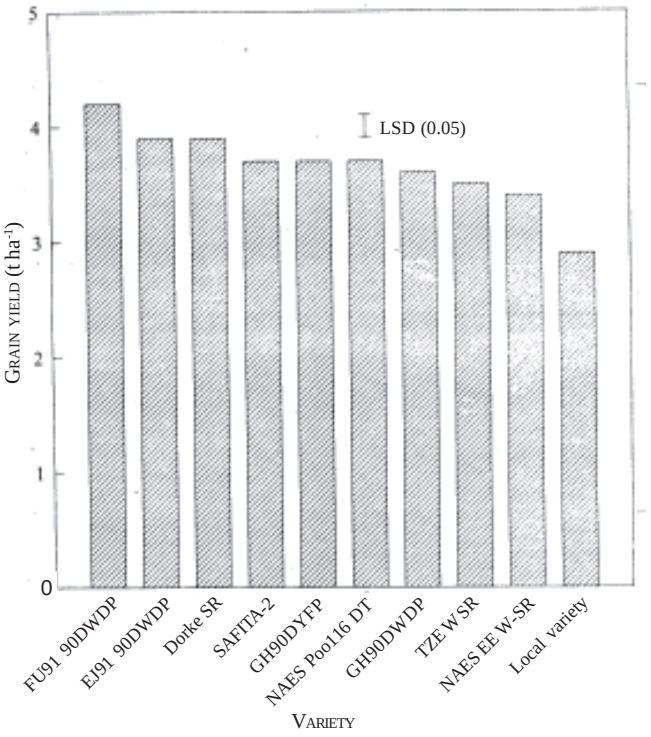

Fig. 1. Grain yields of extra-early and early maize varieties evaluated in 10 research fields in the major agro-ecologies in Ghana in 1995 and 1996.

and early varieties on-station in 1995 and 1996; and Fig. 2, those on-farm. On research stations, the yields ranged from 3.4 t ha^{-1} for the local variety to 4.6 t ha^{-1} for Dorke SR (Fig. 1). The highest yielding entries were Dorke SR and two new experimental varieties, FU91 90DWDP and EJ91 90DWDP. Dorke SR, the early variety grown by farmers throughout Ghana, significantly (P<0.05) outyielded the two extra-early varieties, NAES EE W-SR and NAES Pool 16 DT, by 21.7 and 13.0 per cent, respectively (Fig.1).

In farmers' fields in 1995, NAES EE W-SR yielded 3.3 t ha^{-1} across 38 sites compared to 3.7 t ha^{-1} for Dorke SR, and 3.6 t ha^{-1} for NAES Pool 16 DT and the farmers' check variety (Fig. 2). In 1996, yields across 28 farm sites were 3.1 t ha^{-1} for NAES EE W-SR, NAES Pool 16 DT and the farmers' variety, and 3.5 t ha^{-1} for Dorke SR (Fig. 2). However, no significant yield difference was observed among the varieties in any of the 2 years. Yields across the 66 farm sites in the 2 years averaged 3.2 t ha^{-1} for NAES EE W-SR, 3.4 t ha^{-1} for NAES Pool 16 DT and the farmers' check variety, and 3.6 t ha^{-1} for Dorke SR, with no significant yield differences among the extra-early and early varieties.

Tables 1 and 2 present other agronomic characteristics of the varieties observed on-station and on-farm, respectively. The NAES EE W-SR and NAES Pool 16 DT were the earliest to flower, had the shortest plant architecture, and the lowest grain moisture at harvest in research and farmers' fields. The farmers' local variety was late in flowering, and hence in maturing, compared to the extra-early varieties (Tables 1 and 2). Total lodging was high in all varieties, but it was more severe in NAES EE W-SR than in the other varieties (Table 1). This was possibly because though the extra-early varieties were the first to mature, because of logistic problems, harvesting had to be delayed until the early varieties had also matured. Nevertheless, the need is to improve stand ability in these extra-early varieties and to further enhance their agronomic potentials.

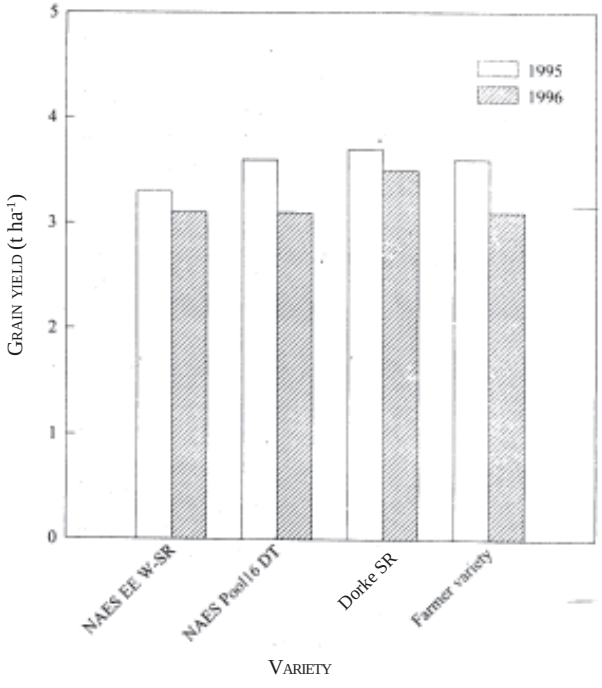

Fig. 2. Grain yields of extra-early and early maize varieties evaluated at 38 farm sites in 1995 and at 28 farm sites in 1996 in major maize-producing zones of Ghana.

The significant yield difference observed between Dorke SR and NAES EE W-SR on-station supports the yield superiority of the early variety over the extra-early variety (Sallah, Twumasi-Afriyie & Kasei, 1997). Sallah *et al.* (1997) compared the grain productivities of different maturity groups of maize varieties in the Guinea savanna zone and reported 35.0 per cent yield advantage of Dorke SR over NAES EE W-SR. In contrast, the on-farm data did not support these observations; the extra-early and early varieties showed similar yield potentials under the conditions prevailing in farmers' fields. Grain yields of 3.0 to 3.5 t ha^{-1} observed in this study showed that the extra-early maize varieties have high yield potentials in the major maize-growing zones of Ghana.

Maturity traits (days to 50% silk emergence and harvest grain moisture) showed that NAES EE W-SR was the earliest of all

TABLE 1

Maturity Ratings, Height, and Lodging of Extra-early and Early Maize Varieties Tested at 10 Locations in Ghana in 1995 and 1996

Variety	*Mid-silk*	*Plant height*	*Grain moisture*	*Total lodging*
	Days	*cm*	*Percent*	
EJ91 90DWDP	49	157	20.7	21.4
FU91 90DWDP	49	167	20.9	22.2
GH90DWDP	50	160	21.0	22.5
SAFITA-2	51	163	21.4	21.7
Dorke SR	52	174	21.3	23.3
TZE W SR	50	170	20.5	22.3
GH90DYFP	50	156	20.1	22.4
NAES Pool 16 DT	47	152	20.2	24.3
Local variety	53	191	20.9	25.1
NAES EE W-SR	47	149	19.5	28.0
Mean	50	164	20.6	23.5
LSD (5%)	1	5	0.5	NS
CV%	3.5	9.3	9.9	39.6

NS = Not significant at 5% level of probability

TABLE 2

Maturity Ratings, Height, and Lodging of Extra-early and Early Maize Varieties Evaluated on-farm in 1995 and 1996

Variety	*Mid-silk*	*Grain moisture*	*Plant height*
	Days	*Percent*	*cm*
NAES EE W-SR	43	19.3	160
NAES Pool 16 DT	45	20.3	161
Dorke SR	50	22.2	184
Farmer variety	54	23.6	205
Mean	48	21.3	178
LSD (5%)	1	0.8	7
CV%	6.2	23.4	13.4

the varieties tested, whereas the farmers' variety was the latest. Though data are not presented, farmers who collaborated in the on-farm trials and those who visited the trials expressed keen interest in the extra-early varieties. Trials were lost at several sites because other farmers managed secretly and saved seed of the extra-early varieties from the trial plots. In addition, several farmers continue to request for seed of the extra-early varieties.

Consumer acceptability is an important criterion for releasing all new maize varieties because maize is a major staple in the diet of the Ghanaian. Fig. 3 shows the overall acceptability, based on sensory scoring for flour colour and texture, food appearance, smoothness and taste, of NAES EE W-SR and other varieties in three maize food preparations. The local maize variety is the most preferred in local dishes, and was the standard for comparing improved varieties for this trait. Sensory scores of taste and the overall acceptability in “Tuo zaafi”, “Ga kenkey” and “Fanti kenkey” were at least as high as or were significantly higher for most improved varieties compared to the local variety (Fig. 3). The results showed that NAES EE W-SR was equally acceptable to consumers in maize-based foods as the local maize variety.

The data presented showed the following: (i) NAES EE W-SR had high yield potential on-station and in farmers' fields; (ii) NAES EE W-SR was equally acceptable to consumers compared to local maize in the various local dish preparations;

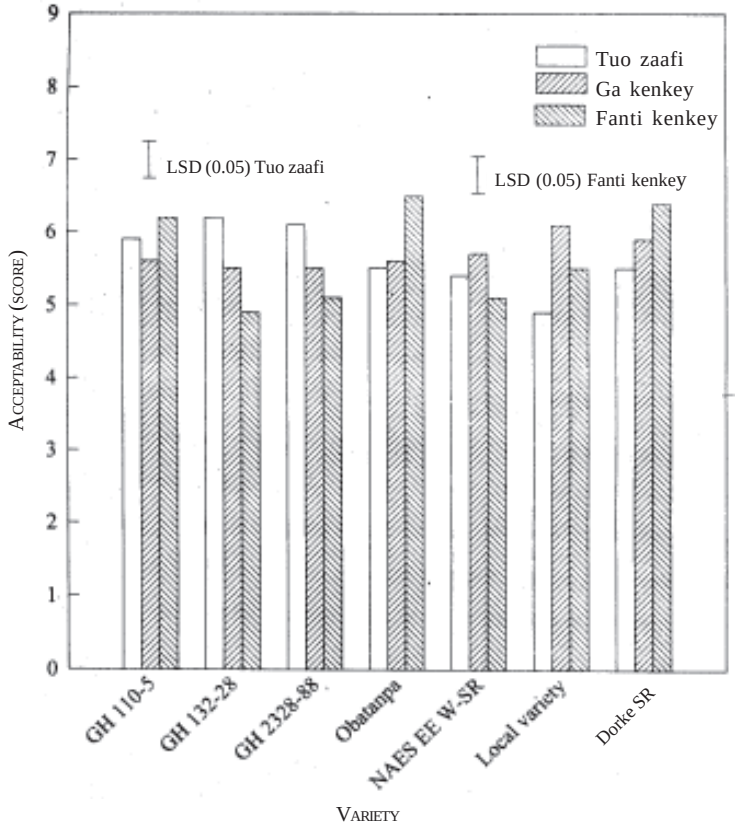

Fig. 3. Sensory evaluations of six improved maize varieties and the local variety for consumer acceptability in three maize-based foods.

(iii) NAES EE W-SR was approved and released by the National Variety Release Committee in July 1997 under the local name "Dodzi" (meaning 'have courage' in the Ewe dialect); and (iv) "Dodzi" is recommended for planting and for early harvest throughout Ghana.

Acknowledgement

The authors gratefully acknowledge the immense contribution of individuals to developing and evaluating the new maize variety. Their special thanks are due to Messrs F. Dzoagbe (Nyankpala), A. D. Mohammed (Nyan-kpala), I. S. Mohammed (Damongo), all staff of SARI; to Messrs E. M. Lampoh, R. Kankam, M. Tengan, C. P. K. Dugbenu, D. S. Narh, A. M. Gasso, G. Dagyawa, E. Avah, D. O. Broni, all of CRI, Kumasi; and to the other staff of the Maize Programme at SARI and CRI for their dedication and hard work. Sincere thanks are also due to all members of the on-farm research teams at CRI and SARI, and the staff of MOFA for their help in testing the variety in farmers' fields. They are further grateful to Madam Grace Koyiri and Madam Veronica Dzreke of WIAD, MOFA in Tamale and Kumasi, respectively, for conducting the sensory evaluations reported in the paper. The fruitful collaboration between the Ghana Maize Programme, IITA, CIMMYT, SG2000, and the West and Central African Maize Network needs special mention. Finally, the authors are grateful to the governments of Ghana, Canada, and Germany for providing funds for maize research in Ghana since 1979 through the Ghana-CIDA Grains Development Project and the Ghanaian-German (GTZ) Nyankpala Project.

REFERENCES

Badu-Apraku, B., Twumasi-Afriyie, S., Sallah, P. Y. K., Asiedu, E. A. & Dzah, B. D. (1990) *Development and release of Abeleehi.* CSIR-Crops Research Institute, Kumasi, Ghana (Mimeo). 16 pp.

Badu-Apraku, B., Twumasi-Afriyie, S., Sallah, P. Y. K., Asiedu, E. A., Marfo, K. A., Dapaah, S. & Dzah, B. D. (1992) *The development and release of an early maturing streak resistant maize variety, Dorke SR.* CSIR-Crops Research Institute, Kumasi, Ghana (Mimeo). 22 pp.

Dankyi, A. A., Anchirinah, V. M. & Apau, A. O. (1997) Maize technology adoption in Ghana. In *NARP Maize Technical Report, May 1996-August 1997.* CSIR-Crops Research Institute, Kumasi, Ghana.

pp.100-103.

GGDP(1991) *Ghana Grains Development Project, 1991 Annual Report.* CSIR-Crops Research Institute, Kumasi, Ghana.

Kasei, C. N., Mercer-Quarshie, H. & Sallah, P. Y. K. (1997) Identifying probable dry periods in maize production under a monomodal rainfall regime in northern Ghana. In *Contributing to food self-sufficiency:maize research and development in West Africa. Proceedings of a Regional Maize Workshop, May 29-June 2, 1995, IITA-Cotonou, Benin Republic (*ed. Badu-Apraku *et al*.), pp. 255-263.

Larmond, E. (1977) *Laboratory methods for sensory evaluation of foods.* Canada Department of Agriculture, Ottawa. Publication No. 1637.

Mercer-Quarshie, H., Amankwatia, Y. O., Twumasi-Afriyie, S. & Marfo, K. O. (1993) *Crops Research Institute Medium Term Research Plan, 1993-1997.* CSIR-Crops Reseach Institute, Kumasi, Ghana.

Ohemeng-Dapaah, S. (1994) Analysis of daily rainfall data and its application to maize production in the transitional zone of Ghana. In *Progress in food grain research and production in semi-arid Africa.* pp. 173-179.

Sallah, P. Y. K., Twumasi-Afriyie, S., Badu-Apraku, B., Asiedu, E. A., Akposoe, M. K., Edmeades, G. O. & Dzah, B. D. (1993) *Development and release of Dobidi maize cultivar.* CSIR-Crops Research Institute, Kumasi, Ghana (Mimeo). 10 pp.

Sallah, P. Y. K., Twumasi-Afriyie, S. & Kasei, C. N. (1997). Optimum planting dates for four maturing groups of maize varieties grown in the Guinea savannah zone. *Ghana Jnl agric. Sci*. **20**, 63-69.

SARI (1995) *Report of the 1995 Workshop and Planning Session for the Upper West Region.* Savannah Agricultural Research Institute, Nyankpala, Tamale (Mimeo).

Steel, R. G. D. & Torrie, J. H. (1980) *Principles and procedures in statistics: a biometrical approach.* McGraw-Hill Book Company Inc., New York.

Twumasi-Afriyie, S., Badu-Apraku, B., Sallah, P. Y. K., Haag, W., Asiedu, E. A., Marfo, K. A., Ohemeng-Dapaah, S. & Dzah, B. D. (1992) *Development and release of Obatanpa, an intermediate maturing quality protein maize variety in Ghana.* CSIR-Crops Research Institute, Kumasi, Ghana (Mimeo). 19 pp.

WECAMAN (1992) *Compilation of data from 1991 regional uniform variety trials.* West and Central Africa Collaborative Maize Research Network, OAU/STRC, SAFGRAD/IITA, Ouagadougou, Burkina Faso.

WECAMAN (1993) *Compilation of data from 1992 regional uniform variety trials.* West and Central Africa Collaborative Maize Research Network, OAU/STRC, SAFGRAD/IITA, Ouagadougou, Burkina Faso.

WECAMAN (1994) *Compilation of data from 1993 regional uniform variety trials.* West and Central Africa Collaborative Maize Research Network, USAID/IITA, Bouake, Cote d'Ivoire.

WECAMAN (1995) *Compilation of data from 1994 regional uniform variety trials.* West and Central Africa Collaborative Maize Research Network, USAID/IITA, Bouake, Cote d'Ivoire.