1. MAIZE PRODUCTION CONDITIONS IN INDONESIA AND FUTURE PROBLEMS

Achmad WAZIR* and Surjatna EFFENDI**

*Chief, Food Crop Production Division, Directorate Agriculture Extention, Department of Agriculture, Djakarta, Indonesia
**Assistant Corn Breeder and Assistant Corn Agronomist, Central Research Institute for Agriculture, Bogor, Indonesia

Introduction

Next to rice maize is the most important crop in Indonesia and serve as staple foods in the diet of the people. This crop has been grown for centuries and at the present time occupies ±3 million hectares of which 43% is concentrated in East Java, 24% in Central Java, 5% in West Java, 10% in South Sulawesi, the rest is scattered over the remaining provinces.

Most of the maize planted in Indonesia has a short maturity period with a low yielding potential. These early maturing varieties are grown at low elevations, principally on the coastal plains of Java.

Sixty five percent of corn is grown at an elevation between sea level and 250 meters and less than 90 days to mature. The average temperature of these main maize area ranges from 23–28°C which permit the cultivation of the maize throughout the year but the seasonal distribution of rainfall regulate the pattern of maize culture.

Maize is grown on both wet and dry land mostly in rotation with rice and other annual crops. The biggest plantation of maize commonly harvested during the wet season (December–March).

The maize industry in Indonesia up to now is made up most entirely of smallholder farms. The improved technology is not widely practiced and this might explain why the average yield is still very low (±0.9 ton per hectare).

Research

The present maize breeding program in Indonesia is focused on the development of high yielding synthetic, composite and open pollinated varieties. The Central Research Institute for Agriculture has developed and distributed four varieties, Malin, Metro, Harapan and Permadi for area of low altitude, which is the main maize growing area. Metro is the most popular one. In order to evaluate the performance and adaptability of several other varieties developed more recently uniform yield trials were conducted at 11 locations in the wet season 1967–1968. Twelve new varieties along with three recommended and on local varieties were included in the trials. The design was randomized block with four replications. The population density was 50,000 plants per hectare and the rate of fertilizer was 135, 80, 50 kg of N, P_2O_5, K_2O respectively. Combined analysis indicated highly significant, variation due to location and varietal effects as well as their interaction. Ten new varieties were found to give higher average yield than Metro on the tracts represented by the trials. Bogor Composite 4,

Table 1. Grain yield (kg/ha sun dry) of different varieties at 11 locations, wet season 1967/1968.

Variety \ Location	Taman-bogo	Kunin-gan	Hardjo-sari	Ampel	Ngale	Delanggu	Modjo-sari	Kedjajan	Muneng	Wongso-redjo	Genteng	Mean	% over *Metro*
Eto Synthetic 1(2)	3,340	4,390	4,425	2,542	2,870	1,680	610	1,931	3,010	3,430	1,495	2,751	94
Eto MS_2	3,870	6,425	3,505	2,385	3,200	1,570	720	2,616	3,315	3,195	1,775	2,961	101
Eto × Dorado	4,255	6,340	4,380	2,854	3,695	1,545	830	1,831	3,220	3,685	1,910	3,140	107
Wonosobo Composite	5,195	6,440	4,716	2,729	3,570	1,660	835	2,571	2,900	4,010	1,700	3,291	113
Metro Synthetic (2)	4,080	4,965	3,980	2,667	3,855	1,355	875	2,537	3,345	3,645	1,585	2,990	102
Rocol V 351	3,705	4,890	3,650	2,083	3,135	1,405	675	2,005	2,530	3,295	1,200	2,597	89
Bogor Composite 1	4,675	5,500	3,755	2,687	3,585	1,580	275	2,910	2,835	3,355	1,515	2,970	102
〃 〃 2	4,620	6,220	3,690	2,896	4,265	1,770	1,190	2,959	2,730	3,595	1,595	3,230	110
〃 〃 4	4,760	6,840	4,090	2,760	3,935	2,055	980	3,325	3,075	3,620	1,345	3,344	114
〃 〃 5	5,020	6,135	3,745	2,458	3,870	1,450	680	2,943	2,780	3,635	1,250	3,088	106
Bogor Synthetic 1	4,380	5,320	4,340	3,359	3,445	1,440	1,480	1,863	3,475	2,885	1,350	3,031	104
〃 〃 3	4,430	6,350	4,210	2,922	3,495	1,490	1,240	2,975	2,845	3,460	1,515	3,176	109
Checks													
*Metro****	3,595	5,860	4,390	2,615	3,600	1,750	585	2,053	2,555	3,790	1,385	2,925	100
Harapan	4,210	5,465	4,380	2,786	3,485	1,665	675	2,461	2,835	4,170	1,840	3,088	106
Bogor Synthetic 2 (Permadi)	4,705	6,460	4,165	2,927	3,645	1,780	1,305	2,269	2,890	3,345	1,575	3,188	109
Local variety	5,020	4,550	1,835	2,448	2,455	735	1,025	2,375	600	3,195	550	2,253	77
Mean	4,366	5,793	3,954	2,695	3,507	1,558	874	2,476	2,809	3,519	1,466		
L.S.D. at 5%	812	747	621	456	485	465	439	932	675	469	469		
C.V. (%)	13.2	9.1	11.1	11.9	9.1	21.0	35.1	16.3	16.8	9.3	22.3		

*** Improved by controlled mass selection.

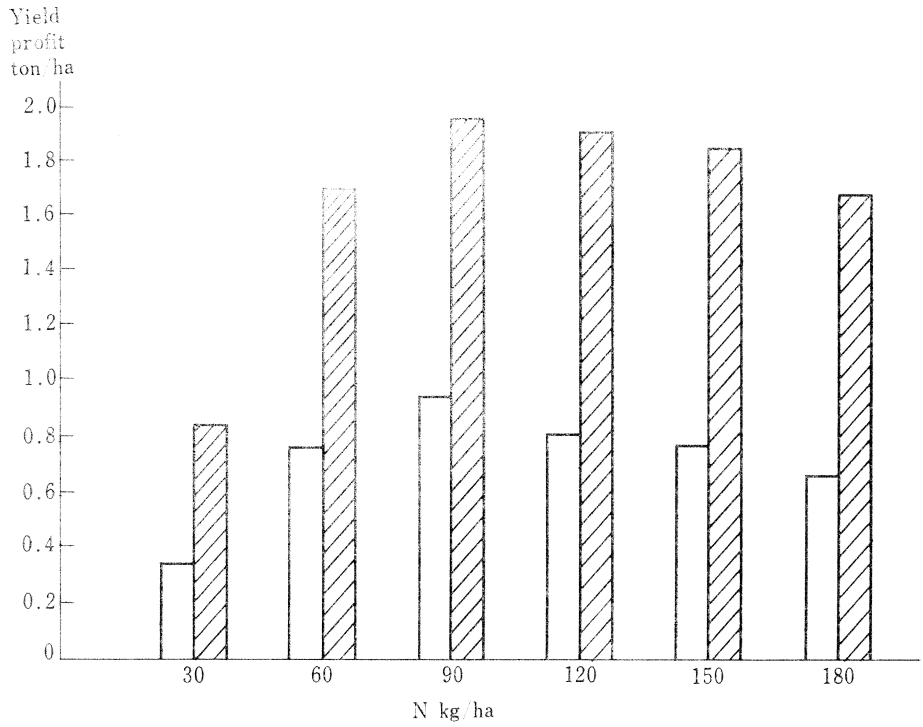

Fig. 1. Effects of nitrogen fertilizer rate on yield profit of corn in ton per hectare of dry grain.

Wonosobo Composite and Bogor Composite 2 were the top yielders showing on an average 14 percent, 13 percent and 10 percent higher yield than Metro, respectively. The first two were significant and the last was close to significant level. The days to 75% silking of Composite 2 and Composite 3 was about 3 days earlier than Metro. Among the recommended varieties Permadi (Bogor Synthetic 2) was the top yielder, giving an average yield of 9 percent higher than Metro. Permadi, Bogor Synthetic 1 and 3 local variety were less attacked by *Sclerospora maydis* (Rac.) Butl. than the others. Further trials are needed in order to obtain a more reliable picture on the performance and adaptability of the new materials. In the agronomic stand point of few yielding of these varieties with a longer maturing varieties have been developed in Indonesia, and new efforts are being made to explore the agronomic practices will make possible the realization of this yielding potential.

In this paper a summary is given of some results obtained in the study of factors, particularly using fertilizers with longer maturing varieties and see the economic feasibility.

Field experiments were conducted at Tjimanggu, Muara, Kuningan, Tjitajam, West Java, Djember, Malang (3 places), Pasuruan and Bondowoso in East Java. Unless otherwise noted field experiments were conducted with the variety Pendjalinan (85 days) and Harapan (100 days) using 50,000 plants per hectare spaced 100 by 40 cm with two plants per hill. Fertilizer was applied individually to each hill in two sites 7.5 cm to the side of the plant and 10 cm below the surface of the soil. Urea, triple-superphosphate and muriate of potash were used. Normally all phosphorus and potassium and one-third of the nitrogen were applied at planting and the remainder of the nitrogen was applied 21 days later. The plot size was 5 by 10 m with 3 by 8 m being harvested for yield. Split-plot design was used with three replications. Yield was reported on a sun-dried basis (about 12 percent moisture). Nitrogen was used at a level from 0–180 kg per hectare. Phosphorus and potassium was used as a basic dressing at the amount of 30 kg P_2O_5 and 30 kg K_2O per hectare. The interaction of fertility level × variety is significant. Harapan responded positively to applications up to 1 and even 2 quintals of Urea per

Table 2. Effects of rates of nitrogen on yield of maize (var. Pendjalinan, 85 days) on Redish Brown latosol soil. (the data are average results from 10 field experiments)

Rate of N	Yeild qt/ha	Yield inc. quintal	Value of inc. Rp.*	Cost of fert.	Return per Rp.*	Profit per ha in Rp.*
0	7					
30	14.4	7.4	13,320	7,500	1.7	5,820
60	20	13	23,400	9,500	2.9	13,900
90	21.5	14.5	26,100	11,500	2.2	14,600
120	22	15	27,000	13,500	2.0	13,500
150	22.1	15.1	27,180	15,500	1.7	11,680
180	22.1	15.1	27,180	17,500	1.5	9,680

1) Maize valued at Rp. 18,— per kg. Fertilizer valued at Rp. 30,—per kg of Urea plus Rp. 5,500, —for triple-superphosphate+muriate of potash and application cost.

*) Rp. 300, —equal to $1.—

Table 3. Effects of rates of nitrogen fertilizer on yield of maize (var. Harapan, 100 days) on Redish Brown latosol soil. (the data are average results from 10 field experiments)

Rate of N	Yield qt/ha	Yield inc. quintal	Value of inc. Rp.*	Cost of fert.	Return per Rp.*	Profit per ha in Rp.*
0	9					
30	22	13	23,400	7,500	3.1	15,900
60	31.5	22.5	40,500	9,500	4.2	31,000
90	35	26	46,800	11,500	4.0	35,300
120	35.2	26.2	47,160	13,500	3.4	33,660
150	35.4	26.4	47,320	15,500	3.0	31,820
180	35.4	26.4	37,320	17,500	2.7	29,820

1) Maize valued at Rp. 18,—per kg. Fertilizer valued at Rp. 30,—per kg of Urea plus Rp. 5,500, —for triple-superphoshate+muriate of potash and application cost.

*) Rp. 300—equal to $1.—

hectare. It is possible that the short season varieties like Pendjalinan are unable to utilize if we given more than 1 quintal of Urea per hectare. The important consideration now is—what rate give the most profit per hectare? It is 90 kg of nitrogen for an increased profit of Rp. 14,600,—for short season varieties like Pendjalinan and Rp. 35,300,—for long season varieties like Harapan (Table 2, 3). As fertilizer use is increased or decreased from this point, profit will decrease. For example, 60 kg of nitrogen gave Rp. 13,900,—profit per hectare and 120 kg of nitrogen gave Rp. 13,500,—for short season varieties and Rp. 31,000,—profit per hectare and Rp. 33,660,—profit per hectare respectively for long season varieties.

Extension

Because of the responsiveness of maize to the input of new technology a campaign was announced in 1962/1963 by the government for increasing maize production on the premise that the intake of carbohydrate should be spread over more feeds than just rice in order to achieve self sufficiency in carbohydrate and save foreign exchange for development projects new going for importing rice.

Being successfully operated in a small scale, in seven distincts in West Java and Central Java, the operation was extended to a rather large area covering ±10,000 hectares in the main maize growing areas. This operation was to secure the availability of the improved seed (Metro) to meet the growing demand at that time. The organization was that the foundation seed was made available by the Research Institute to be multiplied by the Government Estate for stockseed and these in turn distributed to the extension seed-farms and progressive farmers to be multiplied for extension-seeds and made them available for the maize growers.

The production of the foundation seed and the stockseed was financed by a government budget. At the first stage stockseed were given free to the farmers to produce extension seed. The fertilizer (NPK 120–90–60) was supplied as credit in kind.

The supply of fertilizers and the procurement of the extension seed was taken care by the P.N. Pertani, a gov. enterprise with a credit budget from the B.K.T.N.-Bank for cooperative Farmers and Fishery. Incentives was given to the farmers by giving them guarantee that the government will pay the different at market price if they don't get 1,600 kg per hectare by using recommended practices.

It was in 1964 when the campaign was gaining a momentum, the response was very encouraging. It didn't come only from the farmers alone but also from the exporters who encourage the farmers to grow yellow maize. But situation was changed and the market did not work as has been expected. It was due partly to political situation which forbade export of food commodities but also probably due to lack of organized domestic market which its problem includes handling and storage by farmers, farm market transport, price mechanism, primary marketing cost, country market to city market cost, the price and character of the maize and its product led by demand for maize, etc. This failure caused a draw back in the extension work. The yellow maize campaign that had gaining a good start at the traditionally white maize growing areas like in Central Java and South Sulawesi turn to white very rapidly. This may explain why there were found some mixture in maize exported in 1966 when the demand for export were increasing.

Future Plan

Obviously crops, particularly maize, require comprehensive fertilizer experimental programs. The data now available are inconclusive and do not cover all the important

Appendices

Harvested Area of maize. (in ha and %)

No.	Province	1960		1961		1962		1963		1964	
		Harvested area (ha)	%	Harvested area (ha)	%	Harvested area (ha)	%	Harvested area (ha)	%	Harvested area (ha)	%
1	East Java	1,164,150	44	1,130,197	46	1,340,719	42	1,128,869	45	1,555,530	43
2	Central Java	623,234	24	555,118	23	824,716	26	564,431	21	948,287	26
3	West Java	103,649	4	101,713	4	150,908	4	138,030	5	233,287	6
4	S. Sulawesi	268,437	10	276,726	11	332,795	11	285,643	11	332,690	9
5	S. Sumatera	34,494	1	34,589	1	68,796	2	40,639	2	38,783	2
6	N. Sumatera	13,390	1	16,982	1	19,354	1	18,335	1	25,691	1
	TOTAL	2,207,354	84	2,115,325	86	2,737,288	86	2,175,947	85	3,173,053	87
	INDONESIA	2,639,671	100	2,462,485	100	3,175,116	100	2,533,738	100	3,644,048	100

Source: Central Bureau Statistics.

Production of dry shelled maize. (in ton and %)

No.	Province	1960		1961		1962		1963		1964	
		Production in ton	%	Production in ton	%	Production in ton	%	Production in ton	%	Production in ton	%
1	East Java	1,047,310	43	990,835	43	1,204,676	31	1,002,395	42	1,516,669	40
2	Central Jave	611,772	25	570,240	24	1,023,426	30	568,419	24	1,043,786	28
3	West Jave	108,104	4	119,864	5	194,184	6	138,105	6	280,718	7
4	S. Sulawesi	251,643	11	259,814	11	336,690	10	274,245	12	371,075	10
5	S. Sumatera	41,818	2	27,683	1	70,549	2	22,374	1	32,995	1
6	N. Sumatera	12,575	1	15,996	1	19,440	1	19,860	1	31,369	1
	TOTAL	2,073,222	86	1,984,432	85	2,848,965	80	2,025,398	86	3,309,608	87
	INDONESIA	2,460,117	100	2,283,122	100	3,242,940	100	2,358,537	100	3,768,628	100

Source: Central Bureau Statistics.

soil groups at central maize areas in Indonesia. More trials will be conducted in 1968–1969 wet season.

Due to lack of trained and qualified personnel both for research and extension, the scope and progress of the improvement programme are quite limited. Short courses for extension workers will be conducted, it will start this month at the Research Institute in Bogor. It is planned to test the high yielding Composites on Farmers' field in this wet season. The maintaining of the availability of improved seed should be improved. It has been designed for this purpose a some sort of "Production pocket" covering the main maize producing areas.

Discussion

V. R. Carangal, Philippines: What is the genetic make up of Metro, Maling Metro, Harapan, and Permadi?

Answer: Merto: open-pollinated variety from Guatemala. Malin: the same but developed in Indonesia. Harapan: improved by controlled mass selection from Perta. Per-

madi: I am not sure, but it is open-pollinated variety.

F. Iwata, Japan: I suppose that your country is mainly covered with volcanic ash soils. Phosphorus fixation must be strong. What kind of method do you use to increase the available phosphorus in the soils?

Answer: By limiting and using stable manure. For the area (soils) that have a low pH, we trace the pH first in order to have a good plantation by limiting.

D. Sharma, India: In Table 1 of your paper one of the check local variety gives as high yield as any of the experimental test varieties. Could you please tell us how this local variety came in existence and what is the source of the basic germplasm in this particular variety?

Answer: This local variety is the excellent improved variety that was already recommended long ago to this area (local variety=Harapan).

Y. Yamasaki, Japan: What method are you using for the seed production of synthetic variety and composite variety?

Answer: Synthetic variety: come from several inbred lines. Composite: come from several non-inbred lines.

T. Kajiwara, Japan: What kind of diseases occur in your country, and does only *Sclerospora maydis* distribute as downy mildew?

Answer: *Sclerospora* is the main disease. Others are rust (*Puccinia sorghi*), leaf blight (*Helminthosporium turcicum*), and ear rot (*Fusarium moniliforma*). Insect pests on young plant are seed flies (*Atherigona exigua*), army worm (*Leucania unipuncta*), and earth worm (*Agrotis* sp.). And on old plant are European corn borer and *Helrothis armigera*.

V. R. Carangal, Philipines: How many hectares are planted to Metro and other improved varieties last year? What is your target this year?

Answer: In last year about 300,000 ha. This year 500,000 ha are projected.

V. R. Carangal, Philippines: What is the highest yield of Metro in farmer's field in kilograms per hectare?

Answer: 5 ton/ha.

T. Gonzales, Philippines: 1. Average size of small farms for corn. 2. Weight per quintal. 3. Do you have any problem on farm to market roads for corn as they are grown in the wet season?

Answer: 1. 0.5 ha. 2. 1 quintal=100 kg. 3. Yes.

A. Senanarong, Thailand: 1. How do you utilize your corn products? 2. How do your people eat corn?

Answer: 1. For human consumption. 2. Just boiled, and pounded to grain and prepared as rice.

D. Sharma, India: Are you working on the development of maize hybrids? If no, what you think are the reasons?

Answer: No, because less of technical personnel and facilities, the complication of seed production, and the high price of the seed as well as the need for farmers to purchase new seed each year.

V. R. Carangal, Philippines: How serious is downy mildew and what stage of the plant is the most susceptible?

Answer: Downy mildew is the main disease mostly attacking young plant up to 30 days old.

K. Murakami, Japan: Are the new varieties, Bogor composite 2, 4, etc. the advanced generations from the hybrids of dent and flint combination?

Answer: Yes.