YIELDS AND ACCEPTABILITY OF OPAQUE-2 MAIZE IN THE TROPICS OF COLOMBIA[1]

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SUMMARY

Yield trials with farmers and acceptance surveys were conducted in Colombia in 1969-1970 to assess the potential use of opaque-2 maize in the tropical regions of the country. Yields were variable, particularly from one farm to another. In spite of this variability which may have confused the results, an analysis of variance was applied, using farms as replications. No significant differences were found between two growing seasons, among six regions of the country, and between opaque-2 and the best normal hybrids. There was a marked increase in yields when traditional farmer technology was replaced with a package of cultural practices which included adequate fertility, insect control, and weed control. Opaque-2 hybrids significantly improved the yield potential over the farmer's traditional varieties, whether he used his existing technology or accepted the package of improved practices. Farmer, wholesaler, and consumer acceptability of opaque-2 floury maize was found to be low. This may be improved by education, promotion, and eventual development of a flint-type maize with the same nutritional quality as the opaque.

Introduction

The opaque-2 gene in maize attracted wide attention after the initial laboratory results from Purdue revealed its extraordinary lysine and tryptophane contents in 1963 and 1964. It was incorporated into existing commercial hybrids in the U.S. and many tropical countries, and continues to be of prime interest in many developing regions short on quality protein. The soft nature of the opaque-2 endosperm (Slide 1) is characteristic of the first converted hybrids. This trait is important in the tropics because of its influence on the acceptance or rejection of this nutritionally valuable maize. The value of opaque-2 maize has been amply demonstrated in the laboratory, in rats, mice and voles, in swine, and in malnourished children. Slide 2 shows results in hogs which were fed normal maize, opaque-2 maize alone, and a nutritious diet of normal maize and soybeans - although not equal to the complete ration, the opaque-2 maize is far superior to normal, and is an alternative accessible to the small farmer.

Field Trials in Colombia

Commercial opaque-2 maize double crosses were first released in Colombia in 1969 in sufficient quantity for use by the farmer. To test the yield of two hybrids, H.208 (yellow) and H.255 (white), under farmer's conditions, a cooperative project was initiated between CIAT and ICA in six regions of Colombia (Slide 3). These included the major lowland and medium elevation maize areas from Nariño in the south to Magdalena and Guajira in the north. Opaque-2 hybrids were planted in farmer's fields in semi-commercial plots and compared not only to the local variety normally planted by the farmer, but also to the

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best normal hybrid recommended for each zone. The farmer's traditional cultural practices were compared to an improved cultural package which included weed and insect control, adequate fertilization, and close supervision of the crop. Six agronomists in training with CIAT planted 120 trials during the second season, 1969, and the first season, 1970, and 75 of these trials were harvested successfully. Results presented are based on these 75 trials. These trainees also interviewed farmers, buyers, and consumers to explore the acceptability of this new type of maize.

Results of Yield Trials

Due to many missing treatments, the single replication in each location, and different normal hybrids utilized as checks in different zones, it was difficult to analyze these data in a straight forward manner. Tremendous variability was found both among the farmers and even within some farms. Nevertheless, in one group of 38 trials, it was possible to utilize an analysis of variance to assess the differences between the two seasons, among the six regions in Colombia, between two levels of technology, and between normal and opaque-2 hybrids. In this analysis, the only significant difference was between the two types of technology, as shown in Slides 4 and 5. No difference was found between the two seasons nor among the six regions, as shown in the first slide. There was a significantly lower yield (25%) across other treatments in the plots with farmer's traditional technology, as compared to the improved production package, shown in the next slide. No difference was found between opaque and normal hybrids.

To more critically explore the differences between opaque hybrids and regional varieties, between opaque and normal hybrids, and effects of improved technology, pair-wise comparisons were made in trials with these treatments in common. Slide 6 shows the significant advantage of the opaque-2 hybrid H.255 (white) over the regional varieties, averaging a 36% increase with farmer technology and 30% with the improved package. Technology improved yields of the local varieties and the opaque hybrid by 65% and 69%, respectively. These results indicate the advantage of the opaque hybrid under any level of cultural practices, and also that regional varieties respond equally as well as improved hybrids to the introduction of new practices.

The following slide summarizes these same comparisons for the yellow opaque-2 hybrid, H.208, tested only in the second season. In these trials, the hybrid yielded 57% and 35% more than the regional varieties under farmer and improved technology, respectively. Introduction of an improved cultural package resulted in 40% and 64% yield increase in the hybrid and the regional variety, respectively. Conclusions from these data are identical to those from the white hybrid.

How did opaque-2 hybrids compare with the best normal hybrid for each zone? Slide 8 shows the results of comparisons in 38 trials between H.255 (white opaque) and the best normal hybrid, where there was no significant difference between these two alternatives. The slide also compares H.208 (yellow opaque) with the best normal hybrid in 21 trials, again showing no significant difference between these two types. These results were obtained with farmer's traditional technology, and the following slide demonstrates the same pattern under improved technology. In 21 of the 75 trials harvested successfully, an opaque hybrid was the best entry. Over the hybrids compared in these trials, the opaque maize produced yields less than 5% lower than the normal hybrids. This favorable demonstration of the yields under farmer's conditions of the opaque hybrids encouraged further research and extension efforts. These yields with farmers confirmed previous experimental data from Palmira which showed the opaque hybrids to be equal to normal counterparts. It then seemed feasible to move the opaque-2 maize onto the farm, provided certain problems in acceptability could be solved.

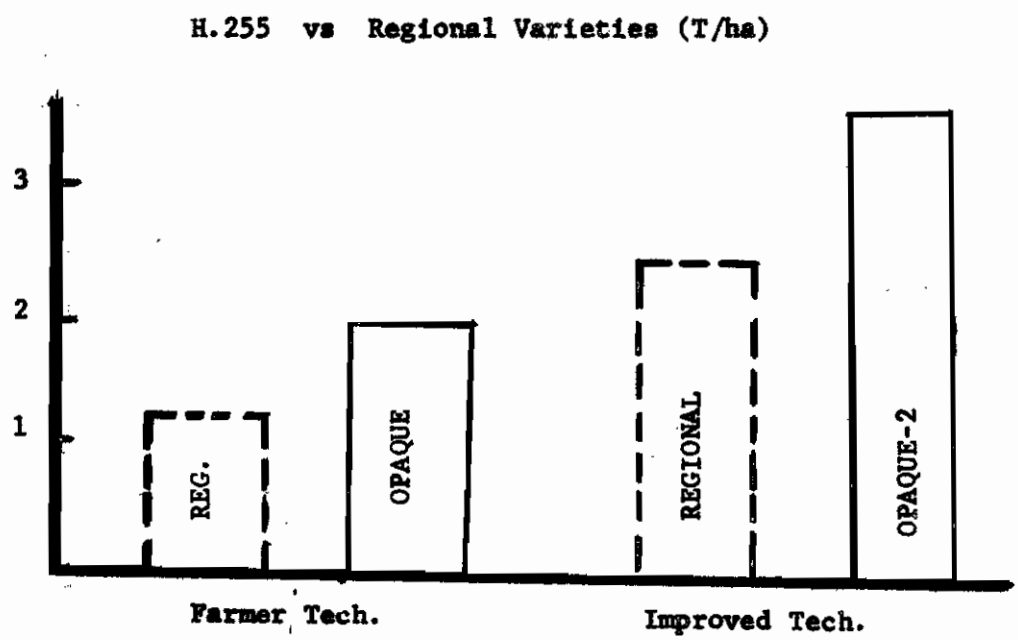
Slide 4. **Maize yields in farmer's fields in two seasons, and six regions in Colombia, 1969-1970 (T/HA).**

SEASONS		REGIONS			
1969B	3.327	I	3.114	IV	5.108
1970A	3.142	II	3.234	V	3.364
		III	2.826	VI	3.093

Slide 5. **Maize yields in farmer's fields using opaque-2 and normal hybrids under two levels of technology in Colombia, 1969-1970 (T/HA).**

HYBRIDS		TECHNOLOGY	
OPAQUE-2	3.066	FARMER	2.866*
NORMAL	3.384	IMPROVED	3.584

Slide 6. **Maize yields of H.255 (opaque-2) and regional varieties under two levels of technology (T/HA).**



Survey of Acceptability

A study was conducted among producers, marketing agencies and consumers to give a quantitative evaluation of the obstacles which would limit introduction, marketing and consumption of this new maize in Colombia. Three surveys were concentrated on the producer - 154 farmers in 12 Departments were interviewed to assess their stage of technology, ability to change, nutritional level, utilization of maize in the diet, knowledge about nutrition, and acceptability of the new opaque-2 maize. A marketing survey was conducted among 25 wholesalers in five towns in Valle department, primarily to assess their attitudes toward opaque-2 maize. Finally, a consumer survey included 30 homemakers in a low-income section of Cali, and 20 in a rural area near Palmira. Each family was given a bag of opaque maize and one of normal, and later asked to compare these two products. Additional information on this maize was obtained from the commercial companies, Quaker and Maizena.

The producer survey suggested that three factors may limit acceptance of opaque-2 maize: lower yields of opaque relative to normal maize, adverse farmer attitudes toward opaque-2, and difficulties in storing this maize on the farm. For the present, farmers expected a higher price for this opaque maize to offset the disadvantages they associated with the crop. At the time of this survey, few of the wholesalers were willing to buy opaque-2 maize, due to a lack of information about potential markets and consumer attitudes. Consumer acceptance was found to be low, due to the floury nature of the grain - a type less used in the areas of the survey. The majority of homemakers would buy the traditional flint maize, if both types were offered at the same price. There was no educational effort whatever in the study of consumers, and the survey results suggested that changes in cooking methods might give much better success in acceptability.

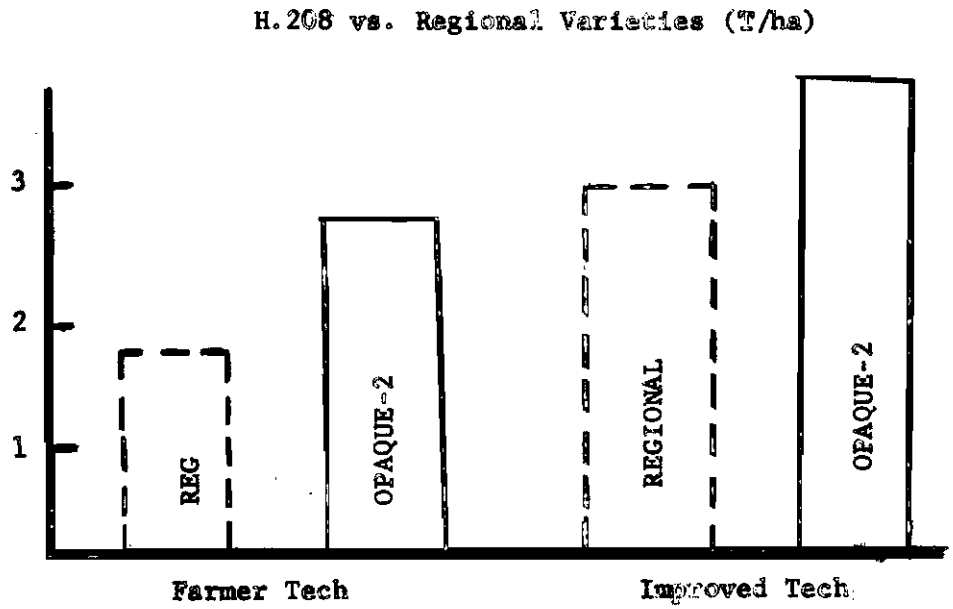
Recent Advances with Opaque-2 Maize

From the results of these studies on farmer yields and acceptability by various sectors, further research and promotion work were planned to find a realistic way to exploit the tremendous protein quality advantage of this new maize. Breeding efforts began to concentrate on development of a crystalline (hard, or flint) kernel which maintains the quality of the opaque-2 (Slide 10). The early results with these flint kernels are very promising - some families have an extremely good lab analysis, and the initial growth results with rats fed this new maize were almost equal to those with the traditional floury opaque-2 maize. Cooperative work with CIMMYT involves testing of some new varieties with this quality characteristic in a flint type maize.

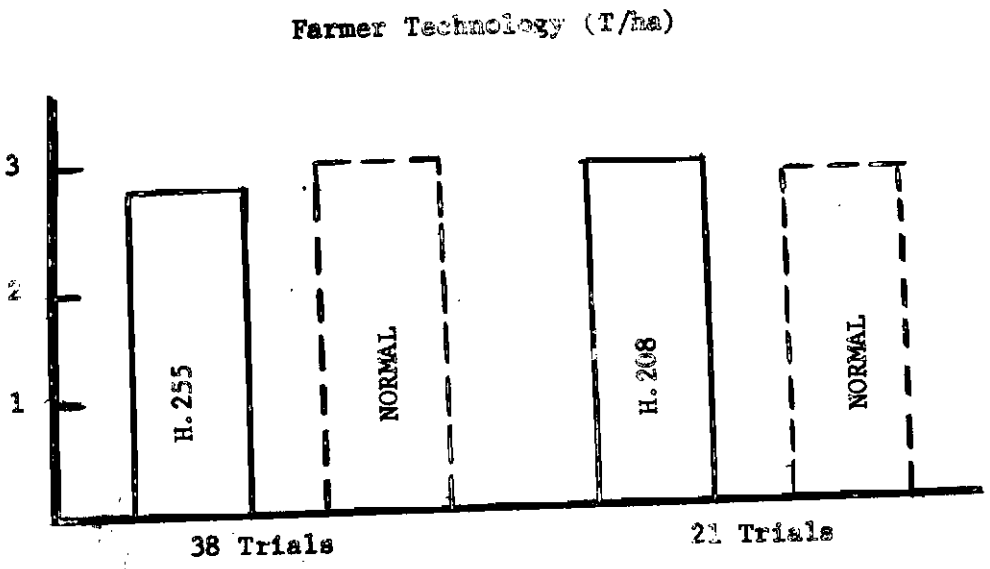
A promotion campaign organized by ICA, CIAT, and other national agencies have continued the demonstration plantings with farmers in several regions of the country, and more recently with feeding trials and demonstrations with hogs. A community-level acceptability study is planned to begin in February with harvest of the current crop. Base line health studies have been carried out over the past 4 years in a barrio near Cali, and changes which result from the introduction of opaque-2 maize will be compared with these base line health and growth curves from the previous work. Recent work with opaque-2 flour shows that this may be substituted up to 20 or 30% in bread, pastries, and spaghetti products without changing flavor or cooking characteristics. This significantly improves the nutritional quality of these products.

These results indicate a tremendous future potential for opaque-2 maize in the tropics. The yield data from farmer's fields are encouraging, and show that introduction of these new hybrids can significantly increase the yields which even small farmers can expect. Educational and promotional campaigns

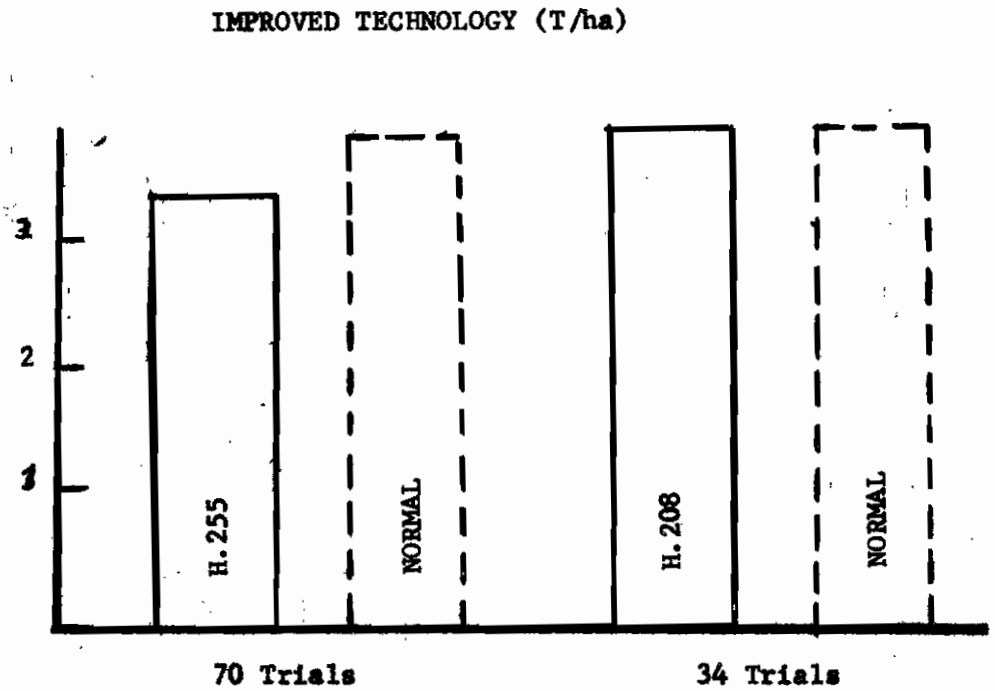
Slide 7. Maize yields of H.208 (opaque-2) and regional varieties under two levels of technology (T/Ha).



Slide 8. Maize yields of opaque-2 and normal hybrids under <u>farmer technology</u> (T/Ha).



Slide 9. Maize yields of opaque-2 and normal hybrids under <u>improved technology</u> (T/Ha).



which stress the nutritional value of this maize relative to other available foods, and show how to modify traditional cooking techniques, is likely to lead to an improved acceptability of this new maize by the consumer. And new selections of flint-type kernels which maintain the protein quality of the floury-type opaque-2 kernel may help in this acceptability, improve storage potential, and help to increase yields.

SLIDE LIST

1. Comparison of opaque-2 vs. normal grains (or ears).
2. Hogs on normal, opaque, and normal maize and soybeans.
3. Map of Colombia, preferably topographic.
4. Comparison among Seasons, Regions in 38 Yield Trials in Colombia, 1969-1970.
5. Comparison between Technology Levels, Hybrids in 38 Yield Trials in Colombia, 1969-1970.
6. Yields of H.255 (white opaque) and regional varieties under two levels of technology (T/ha).
7. Yields of H.208 (yellow opaque) and regional varieties under two levels of technology (T/ha).
8. Yields of Opaque Hybrids compared with best normal hybrids under farmer technology (T/ha).
9. Yields of Opaque Hybrids compared with best normal hybrids under improved technology (T/ha).
10. Selected kernels with modified endosperm from opaque-2 maize.
11. Growth curves of rats fed normal maize, opaque-2 maize, modified opaque-2 maize, and casein.