GM MAIZE PRODUCTIVITY IN SOUTH AFRICA FROM 1999-2019

Food Security, Agricultural Productivity, and Trade in Africa

AAEA Annual Meeting 2021

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SOUTH AFRICAN CONTEXT

Food insecurity continues to be a serious concern for many South Africans

- In 2018, 11% of individuals and 10% of households in South Africa were vulnerable to hunger
- Undernourishment slightly increased from 5% to 6% from 2014 to 2017
- In 2014-2015, 22% of households experienced food insecurity due to a severe drought and subsequent food price shocks
- Maize serves as a staple food for the majority of the population, specifically for low-income households

INTRODUCTION

Most research evaluating the impacts of GM crops focuses on the producer benefits of GM input traits or the influence of consumer valuation and acceptance in GM crop adoption

- Specifically, the producers that have benefited the most are low-income farmers in developing countries where there are fewer options for pest management and crop vulnerability tends to be higher
- Other findings conclude GM input traits have second-order socioeconomic impacts such as labor-savings and environmental benefits
- Many skeptics suggest that there is not clear evidence that GM maize has yield gains in South Africa that benefit producers

PREVIOUS DATA AND METHODS

A previous study was conducted on GM maize in South Africa with emphasis on gains for white and yellow maize cultivars.

- Data collected from 106 locations and 491 cultivars across 28 years (1980-2009) and contained 58,952 observations.
- Data contained both white and yellow maize, with 41% of the data being white maize
- Most trials were dryland and rainfed but 17% were irrigated
- While the data begins in 1980, GM cultivars do not appear until 1999
- Extensive regression modeling with robustness checks were used to estimate heterogeneous GM gains by cultivar and color

Article | Published: 18 February 2021

Yield gains larger in GM maize for human consumption than livestock feed in South Africa

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Nature Food **2**, 104–109 (2021) | Cite this article

PREVIOUS RESULTS

In the study by Shew et al 2021, yield gains were found in both GM white and yellow maize.

- Average GM yield increase was estimated at .42Mt/ha from genetic modification
- GM maize also reduced yield risk by 8%
- GM yield gains vary under different conditions including by province and under irrigated conditions, but **GM yield gains were approximately twice as large for white relative to yellow maize**

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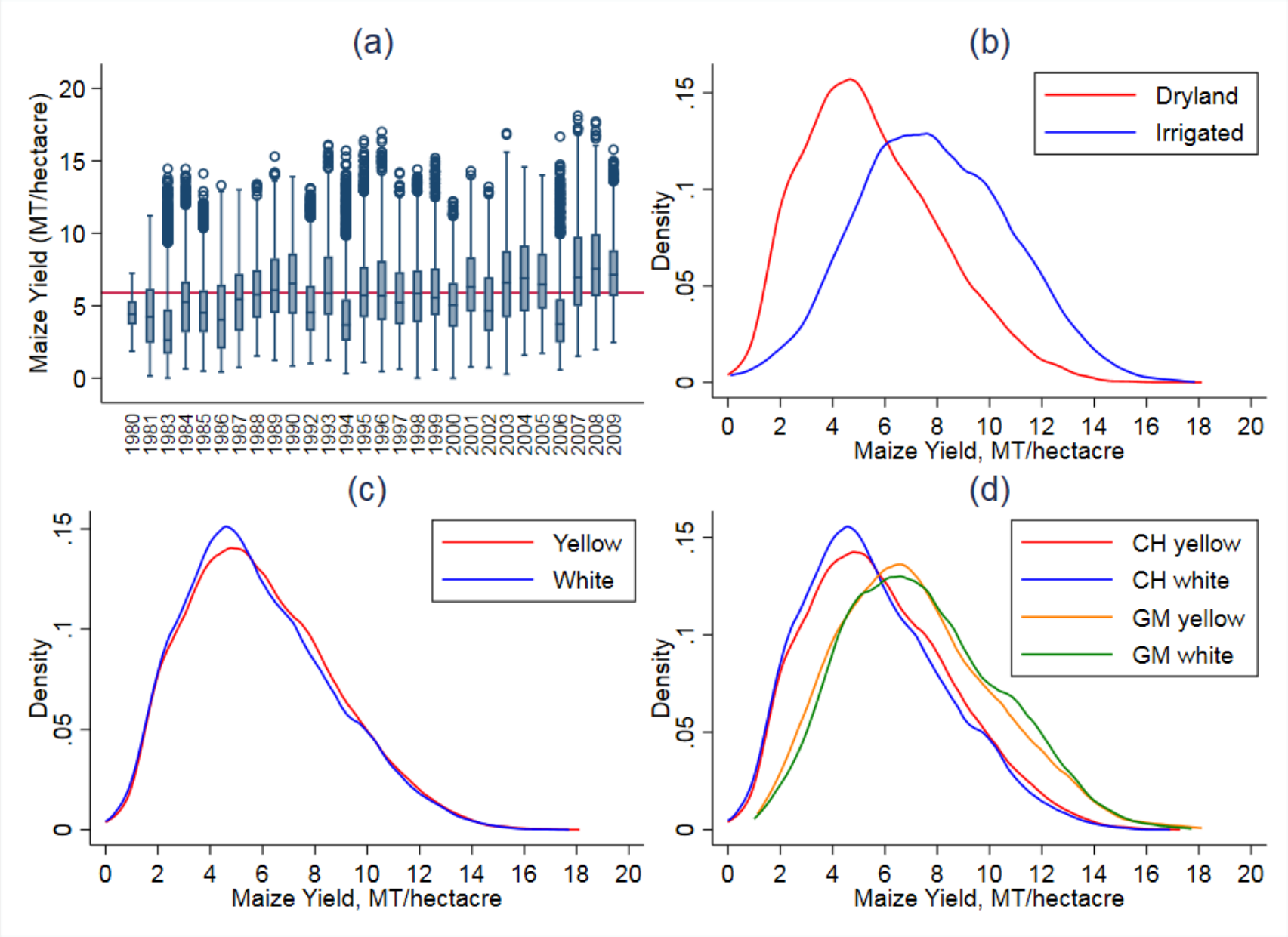

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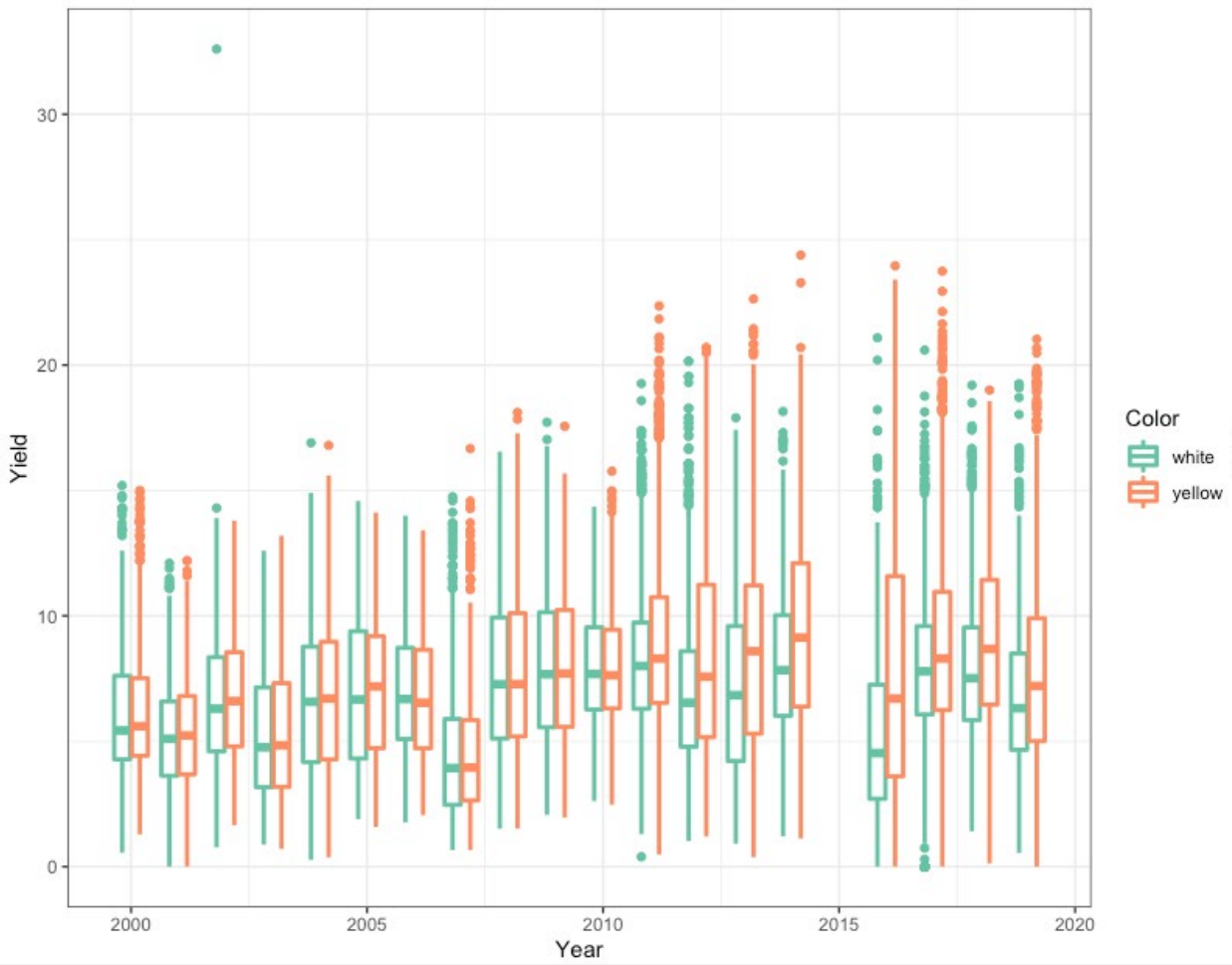
NEW DATA AVAILABLE

For our current study, we took the previous data that ranged from 1980-2009 and added recently aggregated data from 2010-2019.

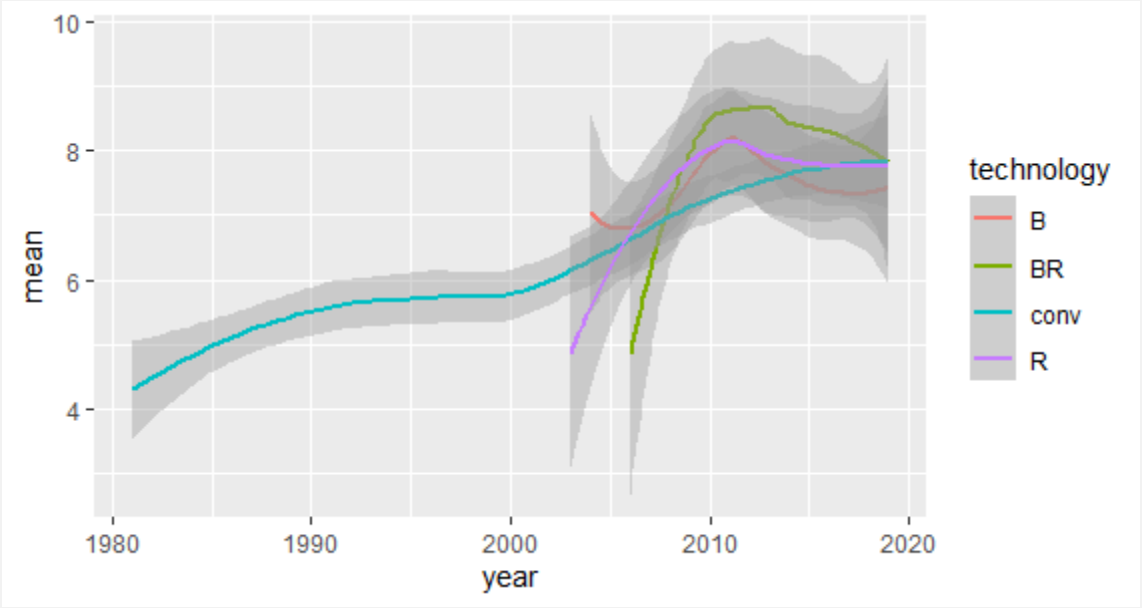
- Data were collected from the South African Agricultural Research Council (and we're very thankful for their collaboration on this project)
- The newly aggregated data was compiled and cleaned in the same manner as the previous data and merged into our panel dataset for analysis
- Data contain color (white, yellow), GM (Bt, stacked Bt/RR, and conventional), province, year, and yield for observations in the updated panel
- Data are missing for the 2015 production year

WHITE/YELLOW YIELDS BY YEAR



BT/CONVENTIONAL YIELDS BY YEAR

- **PLACE HOLDER FOR EXPLORTORY PLOT OF GM VS CONVENTIONAL YIELDS OVER TIME**



METHODS

Linear and Quadratric Regression Specifications

$$yield \sim province + year + GM + color$$

$$yield \sim province + year + GM + year * GM + year\ squared * GM + color$$

Yield is measured in Mt/ha

Province and Year fixed effects

GM for Bt (1) vs Conventional (0)

Color for white vs yellow maize

Interact GM with year and year-squared to capture GM effects over time

LINEAR REGRESSION RESULTS

Original Data

```
GM                0.371704   0.048289   7.697 1.41e-14 ***
coloryellow       0.153308   0.020866   7.347 2.05e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

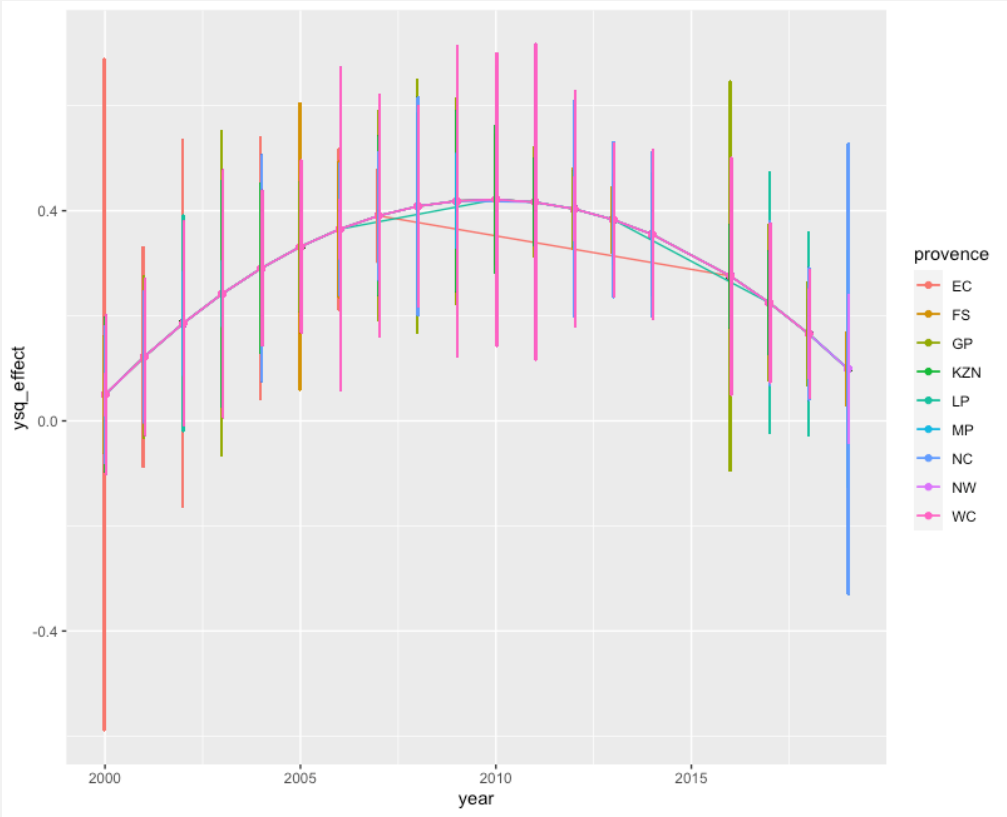
Updated Data

```
GM                0.32766    0.02587  12.666  < 2e-16 ***
coloryellow       0.50441    0.01818  27.742  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

QUADRATIC REGRESSION RESULTS

```
GM                -1.550e+04   6.729e+03  -2.304   0.02123 *
year                      NA          NA      NA        NA
yearsq                    NA          NA      NA        NA
coloryellow        4.991e-01   1.824e-02  27.365   < 2e-16 ***
GM:year            1.543e+01   6.686e+00   2.307   0.02104 *
GM:yearsq         -3.838e-03   1.661e-03  -2.311   0.02086 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

PLACEHOLDER FOR PROVINCE GM BY YEAR EFFECTS IN THE QUADRATIC MODEL



NEXT STEPS

- Quantify the counterfactual GM growth without insect resistance
- Estimating the economic and production impacts of insect resistance
- Breakpoint Analysis by province to analyze heterogeneity in insect resistance

QUESTIONS

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I would like to gratefully acknowledge the South African Agricultural Research Council for providing data for this study.