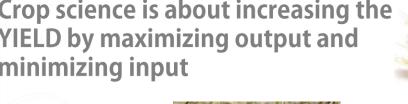


### **Definition**

Crop science is about increasing the YIELD by maximizing output and minimizing input





Tripled weight by dwarfing stalks to support bigger seed heads



Crop protection against pests, diseases & drought





**Application** of fungicides increased yield by 89%

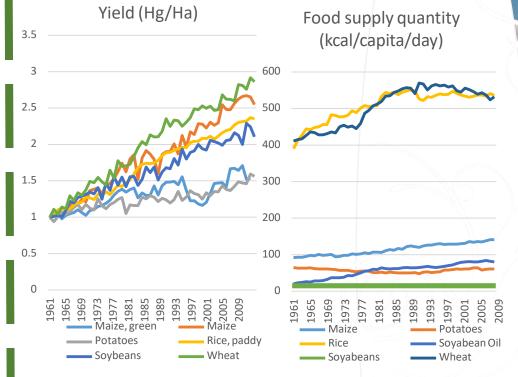
e.g. Wheat

Input management (water, fertilizer, soil, etc.)

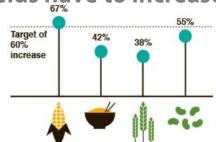


**Split spring** application of N can increase yield by 3 bu/acre

#### Crop science has led to increases in yield, and has helped in addressing the issue of food security.



However, population growth is still outpacing supply. To feed 11B people by 2050, yields have to increase by 60%.





# **AGROCHEMICALS**

Synthetic chemicals for crop protection (e.g. insecticides, fungicides, herbicides) and growth (e.g. fertilizers, hormones)

\$200B at 11% CAGR

7000BC Mesoamerica Maize bred out of teosinte grass 2500BC Sumer Use of sulfur as insecticide

1894-1911
Haber creates process
for mass production of
nitrogen fertilizer

1935 Geigy (now Syngenta) produces insecticides 1940-1960 GREEN REVOLUTION led by Bourlag dramatically increase cereal grain yields 1983 Protestors delay trials by biotech company AGS 1997 Monsanto starts suing farmers for royalty infringement

6000BC Middle East Crop rotation and irrigation 1856-1863 Mendel experiments with plant hybridization 1905-1924 Howard researches on organic farming 1945 Monsanto makes agrochemicals 1982 Monsanto genetically engineers a plant cell 1994 GMO tomato approved by US FDA for groceries

## **ORGANIC**

Use of traditional farming methods and "natural" fertilizers and pesticides

# **CROP SEED & BIOTECH**

Seed and trait development through cross-breeding and genetic engineering, sold via royalties

**\$45B** at 6.5% CAGR

GMO: \$20B at 9.9% | Conventional: \$25B at -6.5%