Consortium for International Seed Technology Training • CISTT •

INTRODUCTION

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SEEDS

- Complex biological structure consisting of a plant in miniature and food reserves protected by covering coats

- Symbols of continuity and diversity;
- A connection between past and future;
- The start and the product of plant development

2

SEEDS

- Important biological function + basis to high agricultural productivity + direct and indirect source of food and essential products

- Evolution of plant breeding x demand for high quality seeds

- Importance of Seed Physiology

3

IMPORTANCE OF SEEDS

1. SEEDS FOR SURVIVAL AND SUBSISTENCE

- Seeds interlink the anhydrous and hydrous states

They resist environmental conditions that would be lethal to the parent plant and propagules used for sexual multiplication

1. SEEDS FOR SURVIVAL AND SUBSISTENCE

- Desiccation tolerance

- Dormancy — Distribution of germination overtime

- Dispersion — Distribution of germination in space

CONTINUITY OF GENERATIONS SUCCESSION

2. SOURCE OF FOOD AND ESSENTIAL PRODUCTS

Direct and indirect sources of food for humans and animals

10 of the most important 22 food sources ➔ grains

Cereals * ➔ Starch (> 60%)

Legumes* { Proteins (23 to 40%), Carbohydrates }

Oil crops { Lipids (30 to 50%), Proteins }

2. SOURCE OF FOOD AND ESSENTIAL PRODUCTS

Raw material or multiplication of plants that produce useful materials for manufacture: fibers, wood, oils, beverages, spices, medicines, soaps, detergents, cosmetics and a wide range of industrial products

3. PLANT MULTIPLICATION

± 350,000 described species

± 250,000 multiplied by seeds

Seeds: sexual multiplication

Propagation: asexual multiplication
vegetative parts, cells and plant tissues capable of regenerating the parent plant

Advantages of sexual multiplication

4. PLANT BREEDING

Seeds: a faster and more efficient way to disperse new cultivars

Seed → the center for alterations planned and selected by plant breeders

Storage of germplasm: collection of genes for interchange

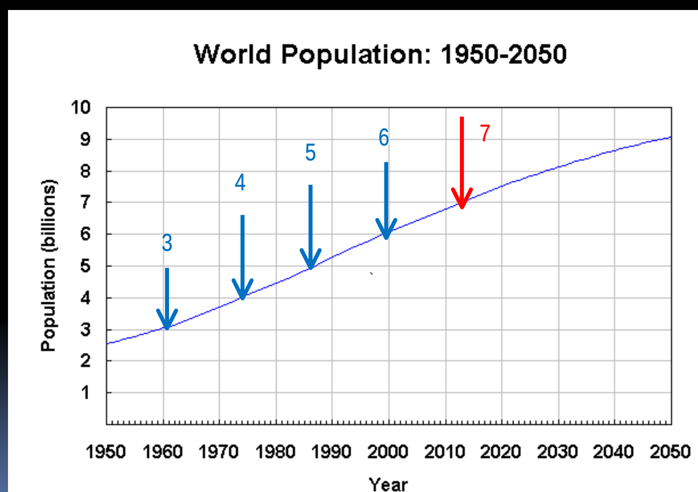
5. AGRICULTURE

Seed is a starter and a product of agriculture

Seed production is a specialized activity

Increases in world population and the challenge to produce food and raw materials

5. AGRICULTURE



Source: U.S. Census Bureau, International Data Base 10-2002.

5. AGRICULTURE

INCREASE IN CROP PRODUCTION

- Increase the land area under cultivation
- Increase the number of crops per unit area per year
- Replace lower yielding with higher yielding crops
- Increase the crop yield per unit area ➔ productivity

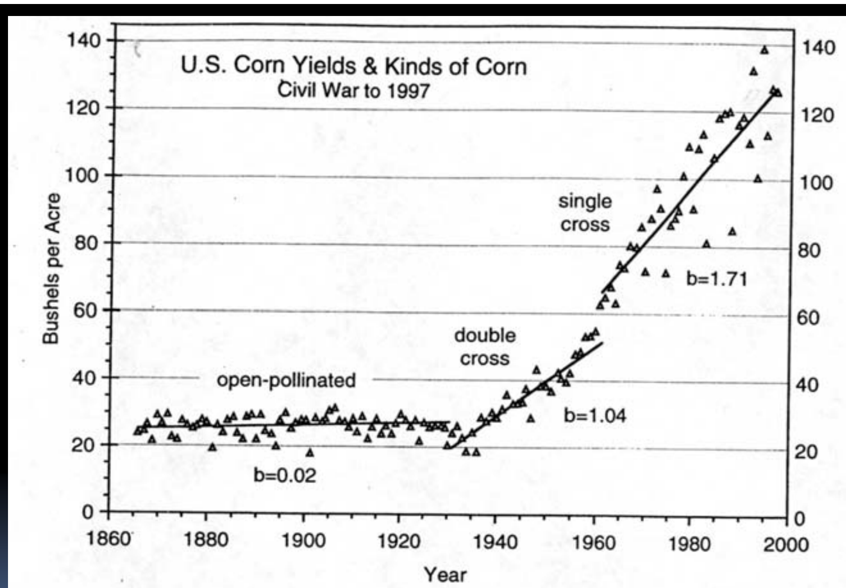
5. AGRICULTURE

Yield / area = cultivar + cultural practices + modern inputs

Yield increase = cultivar (± 70%)

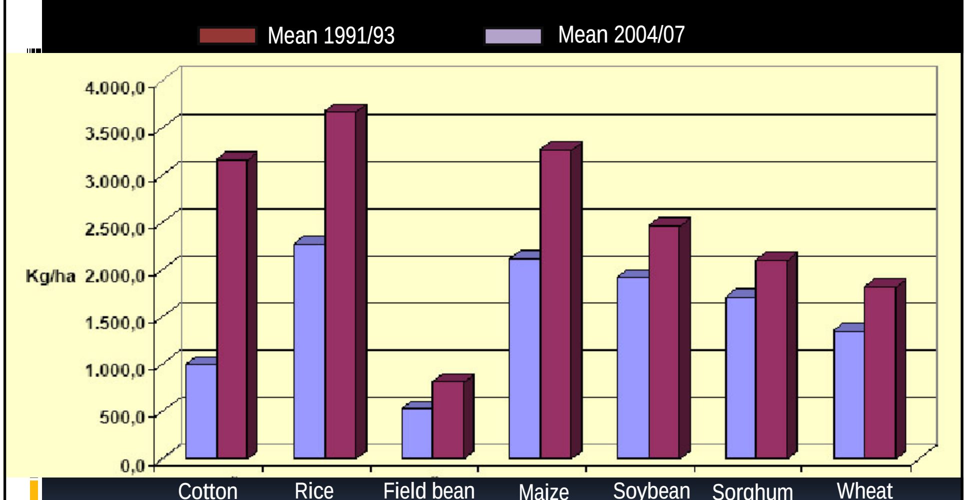
Seeds: direct and indirect effects in crop productivity

The importance of plant breeding

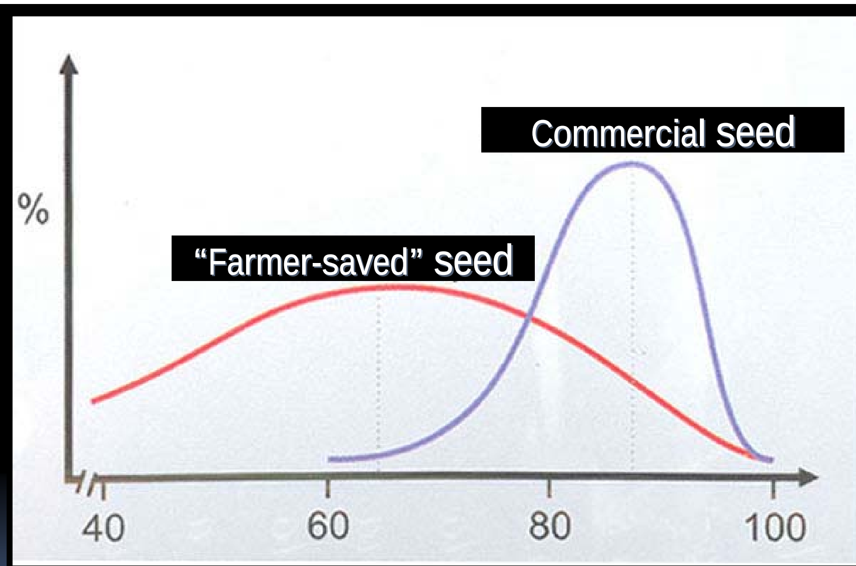


Production of maize (bu/acre) in USA, with emphasis on the periods dominated by open pollinated cultivars, double cross and single cross hybrids (Crow, 1998).

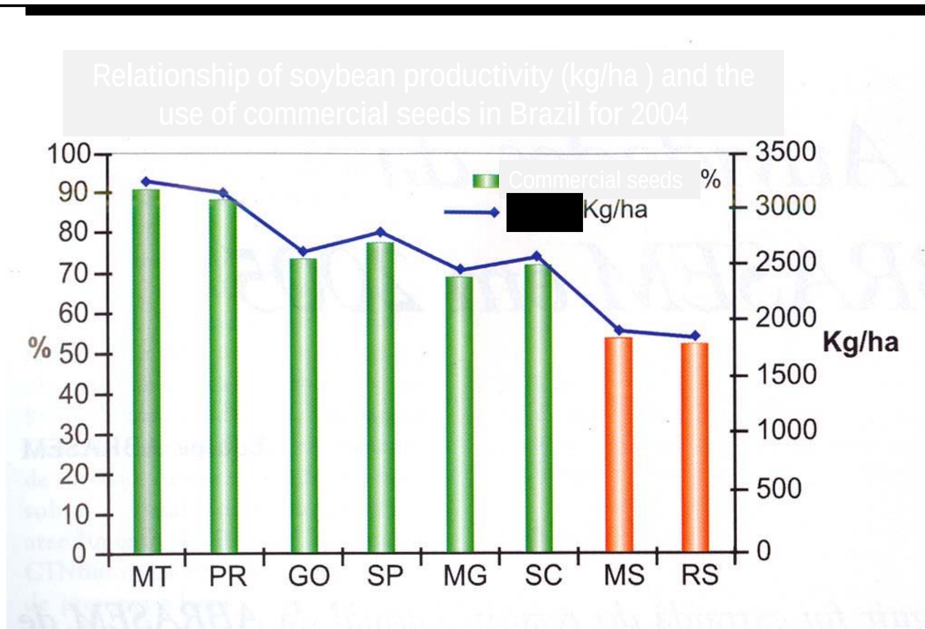
Contreras



Productivity (kg/ha) of important grain crops in Brazil during the last 15 years. (CONAB)



Comparison of the physiological potential (G, TZ, EM) of commercial and "farmer-saved" soybean seed lots used in Bahia State, Brazil (data collected in a drill box survey by Villas Bôas and Peske, 2006)



Miyamoto (2006)

SEED PHYSIOLOGY

18

Even when seeds are genetically almost identical, physiological variation influenced by pre- and post-harvest environmental conditions and management procedures may result in wide differences in seed performance

This situation determines variation between individuals expressed by differences in physiological potential, germinability, dormant status, deterioration level, ...

19

HISTORICAL OUTLINES

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First contact mankind / seed physiology:

Establishment of Agriculture (8,000 B.C. ?)

Germination: a mysterious event or a concern?

Plant domestication in the “New World”

Evenari (1980, 1981)

- Theophrastus (IV A.C.): "first Seed Physiologist"
- Studies about the transfer of plant dry matter ➔ seed
- Factors affecting seed germination
- Coordination of research about seed dormancy, storability, pre-imbibition for germination, maturation / germination relationships

Evenari (1980, 1981)

- Little was added to knowledge about seeds during the following two thousand years
- II B.C.: investigations of Pliny, Varro, Virgil, Columella, Cato

Information to support practical procedures for harvesting, drying, storage, but little research after Theophrastus

Evenari (1980, 1981)

XVII Century

- 1654: seed longevity of garden species (Laurenburg)

XVIII Century

- 1754: relationship of seed moisture content and temperature to seed storability (du Monceau)

XIX Century: first investigations about ovule formation, development of the pollen tube, fertilization, embryogenesis and endosperm formation

Evenari (1980, 1981)

Sachs (1859/1862) ➔ “Father of Modern Seed Physiology”:

dependence of germination on temperature (cardinal temperatures); reserve accumulation during development, mobilization during germination; and biochemical events during germination

- Nobbe (1860, 1876): initial work on Seed Testing and publication of the first handbook on seeds, including physiological principles

Evenari (1980, 1981)

- De Vries (1877/1878): description of the germination process in clover seeds and reserve mobilization during germination

- Hansen (1894), Purlewitsch (1897): action of enzymes for reserve digestion during seed germination

- Late XIX century and early XX century: publication of papers about germination and seedling development, impermeability of seed coats, effects of alternate temperatures, germination promoters and inhibitors of germination

Evenari (1980, 1981)

- Flint and McAllister (1935/1937): relationships of light wavelengths and germination

- Borthwick and co-workers (1952): phytochrome photo-reversibility and influence on lettuce seed germination

HISTORICAL OUTLINES

Remarkable landmark in 1950:

W.J. Franck ➔ seed vigor

Years 1960 and 1970:

- Seed vigor
- Maturation
- Germination
- Dormancy

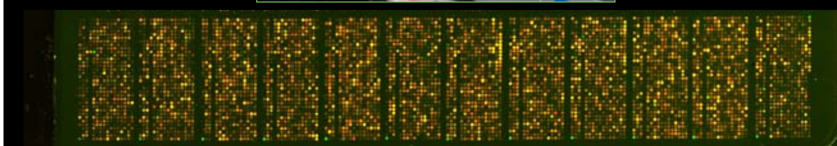
HISTORICAL OUTLINES

Years 1980 and 1990

- Seed priming
- Effects of environmental stresses
- Desiccation tolerance
- Biochemistry of germination and deterioration
- Recalcitrant seeds

Currently

- Image analysis
- Molecular biology tools
- Gene expression : genomics, proteomics, metabolomics, microarrays



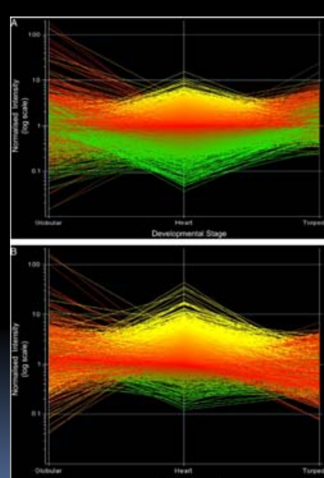
E.g. Arabidopsis ATH1 array, representing 24,000 genes

Henk Hilhorst

Transcriptional changes across seed development time (globular, heart, and torpedo stage embryos) in apical (A) and basal (B) domains

A

B



Spencer, M. W.B., et al. Plant Physiol. 2007;143:924-940

International Research

- Current prevailing themes:

Germination, Maturation, Vigor, Priming, Recalcitrant Seeds, Desiccation Tolerance, Molecular Biology Applications, Image Analysis, Gene Banks, Mechanisms of Gene Expression, Relationships of Proteins and Biological Processes

- Species: grain crops and, in lesser scale, vegetables, forages and forest species

Lack: flowers, fruits, natives, medicinals

CONCLUSION

Seed research has traversed a long path and the accumulation of knowledge has increased over time.

Grain crop seeds have been studied more than other crops

Studies must focus on the different needs and demands of the seed industry, seed technologists, and farmers to assure that research remains active and dynamic and solves relevant problems.

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