

Plant Genetic Resources: Not Just for Plant Breeding Anymore

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Background

- Traditional plant breeder became Research Leader at Griffin genebank in 2001.
- Amazed at range of uses being made of plant genetic resources.
- Presentation at 2002 Crop Science annual conference on “Distribution of Plant Genetic Resources to New Users”.
 - Included short list of non-traditional uses
 - Audience interest in non-traditional uses

Goals

- Symposium
 - Give you a sense of amazement at the wide range of uses being made of plant genetic resources.
 - More importantly, demonstrate the impact that plant genetic resources have had on scientific disciplines other than traditional plant breeding.
- Presentation
 - Give you a sense of amazement at the wide range of uses being made of plant genetic resources.
 - Show that plant genetic resources are a valuable resource for all science.....not just applied production agriculture.

Data utilized

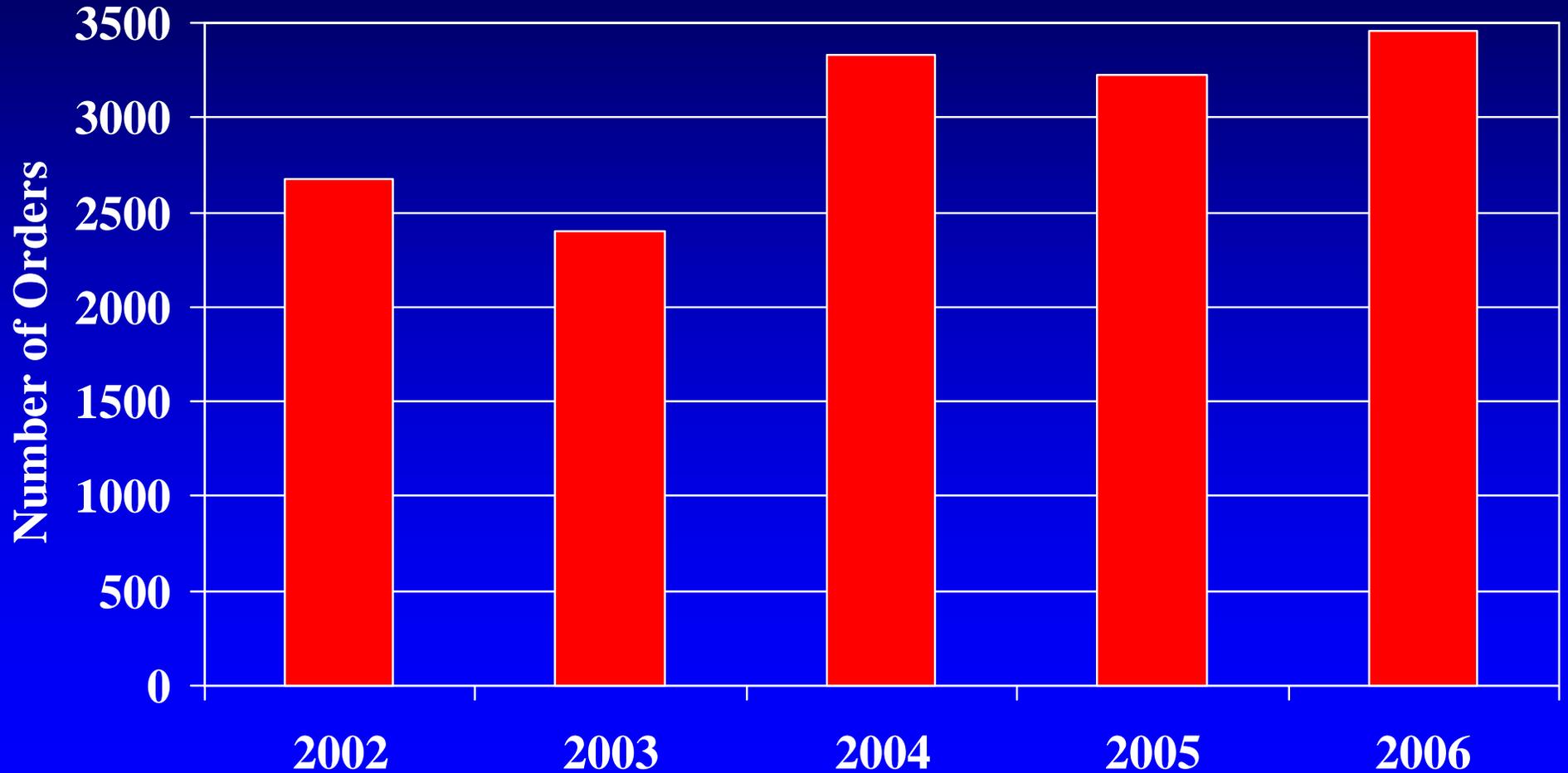
- Data on utilization of genetic resources was obtained from GRIN for five locations:
 - Four regional Plant Introduction stations
 - Ames, Iowa
 - Geneva, New York
 - Griffin, Georgia
 - Pullman, Washington
 - National Small Grains Collection
 - Aberdeen, Idaho

Data utilized

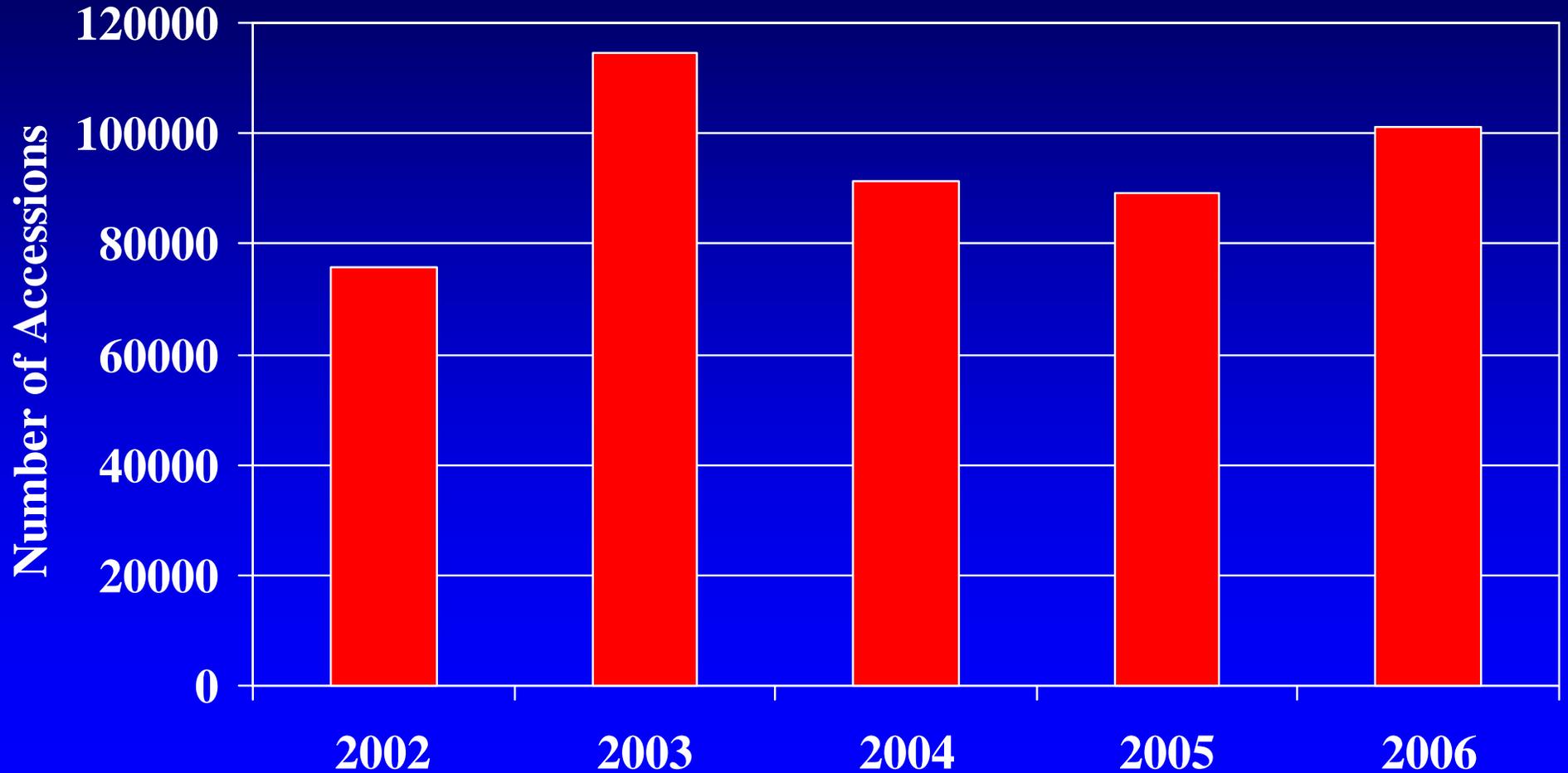
- NPGS locations chosen due to amount of information posted in GRIN on the use made of the accessions for each order.
- Data on both agronomic and horticultural crops will be included.
- Data was obtained from orders or requests for accessions made to the five NPGS locations during a five-year period (2002 – 2006).

Total Number of Orders

(Five NPGS Locations 2002 – 2006)



Total Number of Accessions Shipped (Five NPGS Locations 2002 – 2006)



Accessions requested from five NPGS locations 2002 – 2006

- 15,085 orders made for genetic resources.
- 472,016 accessions shipped to requesters.
- Number of accessions shipped per order ranged from 1 to 24,951.
- Average number of accessions shipped per order was 31.

Traditional Use of Plant Genetic Resources

- Applied plant breeding
- Cultivar and germplasm development
- Selection within species for cultivar development
- Applied research leading directly to cultivar development
- Two CSSA special publications (1991 and 1992)
 - Use of Plant Introductions in Cultivar Development I & II

Non-Traditional Use of Plant Genetic Resources

- Basic and applied research
- Selection between different species
- Studies outside of traditional crop cultivar development
- Research conducted by scientists other than plant breeders

Traditional vs. Non-Traditional Use

- Greatest use of plant genetic resources is still for plant breeding.
 - Half of the 15,085 orders were for plant breeding, cultivar development, research, or undefined.
- 7,605 orders from 2002 – 2006 were evaluated for non-traditional use.
- Information on use was taken from Order Text (REQUEST) and Order Comment (CMT) fields in curator version of GRIN.

Non-Traditional Use of Plant Genetic Resources

- Examples -

Plant Pathology

- Resistance and mechanisms of resistance
 - *Fusarium*, *Sclerotinia*, *Phytophthora*, *Xanthomonas*, *Verticillium*, *Septoria*, *Aspergillus*, nematode, root rot, virus, black rot, downy mildew, soybean rust, powdery mildew, anthracnose, ergot, leaf spot, scab, rice blast
- Race or strain indicator plants
 - Virus isolates, powdery mildew races, fungal differential lines
- Other
 - Alternate soybean rust hosts, hypersensitive response genes, disease susceptibility of relatives for weed control, aflatoxin contamination, host-pathogen interactions, maintenance of nematode populations or pure virus cultures, epidemiology studies

Entomology

- Resistance or mechanisms of resistance
 - Stem weevil, leaf miner, fall armyworm, sunflower moth, thrip, white fly, root maggot, potato leafhopper, hessian fly, rootworm, aphid, greenbug, chinch bug, fungus knat
- Beneficial insects
 - Bee nectar, pollination research, honeybee forage plants, bee pasture testing, plants for honey production
- Insect effects on plants
 - Insect-induced leaf defense response, spider mite, caterpillar, aphid, seed weevil
- Other
 - Insect trap crop, biological control agents, aphid transmission of virus, insect-plant interaction, artificial insect diet, weeds as insect hosts, plant effects on insect behavior

Plant Physiology

- Plant content or biosynthesis
 - Oil, fiber, glucosinolate, inulin, anthocyanin, fatty acid, oxalic acid, methionine, beta carotene, protein, flavonoid, alkamides, coumarin, lipids, antioxidant, polyphenolic, isoflavone, amino acid, tannin, isozymes, gluten, sugar, starch chemistry, ascorbic acid, puroindoline, leaf wax, phytoestrogen, prolamins, leaf alkaloid, diurnal variation in chemical composition
- Physiology
 - Nutritional value, nitrogen use, plant cell biology, photorespiration, photosynthetic metabolism, cell wall digestibility, forage fermentability, phytochrome allelic diversity, mutagenesis research, gibberellin sensitivity

Plant Morphology

- Morphology
 - Root structure, leaf stomatal conductance, leaf number and anatomy, seed coat color, flower volatiles, C4 photosynthesis, floral morphology, leaf crystals, deep root development, phenotypic plasticity, embryology, trichome secretion, cell wall analysis, flower branching, xylem anatomy, glume effects on dust production, flower color, pod morphology, biomass accumulation, rootstock grafting, study of forms in nature
- Reproductive behavior
 - Apomixis, flowering time, pollen tube germination, fertility restoration, photoperiod sensitivity, crossing barriers, seed dormancy, grain hardness, seed mineral transport, hermaphroditism inheritance, cytoplasmic male sterility, germination

Abiotic Effects

- Temperature
 - Winterhardiness, microclimate suitability, high elevation crops, allelic variation in vernalization genes, heat tolerance, frost tolerance
- Moisture
 - Drought, water stress and xylem anatomy, dryland range, dry desert, waterlogging tolerance, xeriscape research, wetland site reintroduction

Abiotic Effects

- Tolerance
 - Aluminum, salt, ozone, boron, low phosphorus
- Soil
 - Alkaline, acid, hard soil penetration
- Nutrient uptake
 - Phosphorus, zinc, magnesium, iron
- Other
 - Herbicide resistance, turfgrass shade research, pollen transfer of herbicide resistance

Phytoremediation

- Phytoremediation studies
 - Arsenic, cadmium, uranium, selenium, actinide, polycyclic aromatic hydrocarbons (PAHs)
- Heavy metal tolerance or accumulation
- Molecular biology of selenium accumulation
- Hyperaccumulation studies

Molecular Biology and Cytogenetics

- Molecular biology and tissue culture
 - Mutation, transformation, tissue culture development, diversity fingerprinting, DNA barcodes, association mapping, transposable elements, gene and QTL discovery, tissue culture organogenesis, chloroplast DNA, grain quality gene mapping, somatic hybridization, polyploidy, protoplast culture, SSR marker development, DNA analysis, AFLP, cell and root cultures
- Cytogenetics
 - Centromere genetic diversity, chromosome structure, flow cytometry controls, chromosome doubling, molecular cytogenetics

Phylogenetics and Genomics

- Taxonomy
 - Molecular systematics, phylogenetic research, genetic diversity links to subspeciation, native species diversity, genetic homology, diversity analysis, genetic comparative map, gene flow, genetic drift, interspecific variation, interspecific crossing
- Genomics
 - Mitochondrial genome sequencing, comparative genomics, genome size analysis, chloroplast genome sequencing, rice genomics

Education

- Classes
 - Economic botany, horticulture, plant ecology lab, plant science, plant taxonomy, sustainable agriculture, plant biotechnology, biology, tissue culture lab, functional ecology
- Display or demonstration
 - Children's garden, crop museum, living history farm, master gardener, tall corn contest, botanical garden living collection, school world garden, ethnic diversity urban garden, plant exploration, inter-cultural heritage garden, fiber and dye crop exhibit, pharmaceutical/nutraceutical demonstration, organic crop, school butterfly garden, inter-city high school, zoo African garden, arboretum, state heirloom garden, American Society of Agronomy centennial

Education

- Projects
 - 4-H garden, home school science, high school science, girl scouts, primary school, fourth grade reclaimed swampland project, undergraduate research, horticulture club, boy scouts, window box and apartment balcony gardening, cub scouts gardening badge, seed savers
- Historical display
 - Crop domestication, native American diet, tribal and ethnic food, history of corn
- Reference material
 - Herbarium, weed seed identification guidebook, plant models for botanical illustrations

Archaeology and Crop Domestication

- Crop domestication
 - Biomarkers to characterize flax domestication, heirloom crops, flowering gene expression in crop ancestors, native species diversity, evolutionary relationships, ethnobotanical study of food plants, crop landrace origins, historical genetic invasion, origin of sweet corn, center of domestication
- Archaeological research
 - Identification of archaeological seeds, reconstruction of prehistoric diet

Crop Management and Ecology

- Crop management
 - Plant competition, green manure, weed biological control, cover crop, harvest index, crop rotation, planting date, fall dormancy, grazing stress
- Ecology
 - Erosion prevention, naturalization, crop diversification, dryland wind barrier use, wildlife habitat, invasiveness

Symbiosis

- Nitrogen fixation
 - Evaluation, nitrogen fixation of kudzu, Rhizobia interactions, drought effects on nitrogen fixation, Rhizobia specificity
- Allelopathy
- Endophyte infection, seed transmission of fungal endophytes
- Arbuscular mycorrhizal symbiosis

Alternative Uses

- Food
 - Dry sprouts, native American natural food, sorghum syrup, fish food development
- Energy
 - Biomass production, biolubricant, ethanol production, biodiesel, alternate oil source
- Medicinal
 - Anti-cancer drug research, gluten free crop, use by Ojibway medicine man, development of edible vaccines in forages, lower glucose values for diabetics

Alternative Uses

- Ornamental
 - Corn pencils, ornamental grasses, alternative turfgrass, landscaping, floral market
- Systems
 - Biological weed control, hydroponic system, industrial, organic potassium source, weed fumigant, paper pulp, poultry pasture, organic farming, biofumigant cover crop, DOT testing, roadside weed control, dairy goat hay
- Other
 - Fragrance production, hurricane plant replacement, use in vineyard to deter deer, methane production in cows, aromatic crop, bird study, dwarf crops for International Space Station

Germplasm Preservation

- Cryopreservation research
- Seed longevity
- Germplasm repatriation
- Foreign genebank
- Tribal seedbank

Conclusion

Plant Genetic Resources are not just for
Plant Breeding anymore!

- Presentation posted at:
www.ars.usda.gov/Main/docs.htm?docid=17633

Plant Genetic Resources Conservation Unit Griffin, GA

