Genetically-engineered (GE) traits in USDA/ARS genebanks and breeding programs

- **Voucher specimens of varieties with deregulated, GE traits protected by Plant Variety Protection ("breeders' rights") are stored but not distributed by the NPGS genebank at Ft. Collins.**
- **After PVP protection expires, NPGS genebanks will distribute those now public-domain varieties with GE traits.**
- **USDA/ARS breeding programs do not incorporate proprietary GE traits.**
- **Two USDA/ARS breeding programs do incorporate deregulated, public-domain GE traits, e.g., papaya, plum. But at present the rest of USDA/ARS breeding programs do not incorporate GE traits.**

GE traits in USDA/ARS genebanks and breeding programs

- **A total of 20 crops include varieties with deregulated (U. S.) GE traits, but five account for the overwhelming majority of those widely cultivated in the U. S.:**
  - **Alfalfa**
  - **Cotton**
  - **Maize**
  - **Soybeans**
  - **Sugarbeets**
- **Some widely-grown currently proprietary, varieties with "1st generation" deregulated GE traits will soon become public-domain (a few in 2015, more in subsequent years).**
- **They will be distributed by NPGS genebanks, and will likely be incorporated into USDA/ARS and university breeding programs.**

USDA/ARS plant breeding programs

- **Genetic enhancement ("pre-breeding") and varietal breeding programs for all major U. S. crops, and many specialty or horticultural crops.**
- **About 400 new crop varieties and genetically-improved populations released by ARS in 2014.**
- **For the most part, varieties are publicly-released, but a few are released exclusively when necessary for successful technology transfer.**
- **Many USDA/ARS plant breeding programs are conducted in close cooperation with state universities and commodity groups.**

GE traits in USDA/ARS genebanks and breeding programs

- **The AC 21 recommendations, the impending availability of public-domain varieties with GE traits, and the need to minimize adventitious presence (AP) of GE traits in non-genetically-engineered germplasm and varieties, stimulated USDA/ARS to review and enhance its current procedures and best management practices (BMPs).**

- **USDA/ARS NPGS genebanks and breeding programs have always aspired to deliver germplasm and varieties that are as true-to-type as possible, with minimal off-types.**
- **GE traits and varieties with those traits present challenges: off-types detectable at very low frequencies; high impact.**

Procedures and best management practices (BMPs) for GE traits in USDA/ARS genebanks and breeding programs

- **Developing procedures and BMPs for genebanks and breeding programs involves numerous challenges.**
- **For genebanks:**
  - **Highly diverse materials**
  - **Small sample sizes, often few seeds**
  - **Diversity of germplasm sources**
  - **Diversity of germplasm recipients**
- **For breeding programs:**
  - **Same challenges as for genebanks, and:**
  - **Some breeding procedures require large populations of field-grown, sometimes open-pollinated plants.**
  - **Effective evaluations involve cultivation at multiple locations, over multiple seasons, in diverse nurseries.**

Procedures and BMPs for GE traits in USDA/ARS genebanks and breeding programs

- **Compromise between the ideal and the practical.**
- **Exploit the existing well-developed BMPs for managing germplasm in genebanks, and breeding lines in crop improvement programs.**

- **Five primary elements for the procedures and BMPs:**
  - **BMPs per se, tailored to individual crops**
  - **Testing at key points**
  - **Mandatory testing before release of varieties**
  - **Mitigating AP**
  - **Communication strategies**

Procedures and BMPs for GE traits in USDA/ARS genebanks and breeding programs

- **BMPs for maintaining trueness-to-type:**
  - **Well-documented, reviewed, accessible**
  - **Crop-specific risk analyses**
  - **Methods for assuring genetic integrity**
  - **Required documentation**
- **Testing for trueness-to-type:**
  - **Critical control points and decision trees**
  - **Threshold for testing (<1%)**
  - **Recommended laboratory tests and sampling procedures**
- **Mandatory testing before varietal release (see above).**

Procedures and BMPs for GE traits in USDA/ARS genebanks and breeding programs

- **Mitigating the effects of AP off-types:**
  - **Communications**
  - **Testing**
  - **Alternative germplasm sources**
- **Communication strategies:**
  - **Information about procedures and BMPs**
  - **Notification procedures and sequences**