Component I: Systematics and Identification

1b. Weed Systematics and Taxonomy (U.S. Value 2007: $27 billion)

Problem Statement: Successful control and management of noxious weeds on over 100 million acres of agricultural, public lands, right-of-ways, and native natural habitats is limited by confusion over basic knowledge of:

- Identification of Weed Species
- Genetic Relationships of Weeds to Other Plant Species
- Hybridization/Introgression Involving Weed Species
- Population Structure of Weeds
- Unknown Origin of Genetically Distinct Populations of Weeds

Research Needs:

1. **Identification of Weed Species**

   Importance: The identification of several key weed species is challenging and in some cases the species name is unknown or controversial. Without proper identification of weeds, it is difficult to determine their distributions, impacts, and origins. This lack of information leads to increased environmental impacts when weeds are not efficiently controlled, wasted economic resources when management is focused on the wrong target, and damaged desirable plant species when they are incorrectly identified as weed species.

   Research Gaps: For many plant groups, identification can be outsourced to experts of that taxonomic group, but for some genera and species, for which ARS is conducting research, there are no non-ARS experts and ARS botanists must fill in those gaps.

   Actions: ARS will:

   - Clarify identification of key or newly detected weed species.

2. **Genetic Relationships of Weeds to Other Plant Species**

   Importance: Biological control of weeds requires knowledge of a weed's relationship to other native and non-native plant species in order to be able to accurately assess the host-specificity of potential control agents (insects, pathogens). If relationships are unknown, there is the potential to incorrectly affect non-target organisms.

Research Gaps: For many taxonomic plant groups that are subjects of ARS research, knowledge of genetic relationships has not been adequately resolved. Recently, many systematic classifications based on morphology alone have been radically altered by molecular evidence.

Actions: ARS will:

- Use the best available analysis methods, such as molecular methods, to determine genetic relationships of key weed species.

2. Hybridization/Introgression Involving Weed Species

Importance: When species are introduced to new areas, there is risk that they may hybridize with other closely related species in the area. Novel hybrids may be created, or through introgression (back-crossing with parental species), native species may be polluted with non-native genetic material. Many invasive weeds are the result of hybridization events, which remix genetic material and potentially produce a wide array of genotypes. Some of these genotypes may have enhanced invasive properties.

Research Gaps: Many hybrids are physically indistinguishable from nonhybrids and putative hybrid events usually require DNA analysis to determine identity and abundance. When hybrid events are detected, it is not always known how much the plants are more like one parent species or the other, which may affect biological control efforts. Additionally, when non-natives hybridize with other species, DNA analysis is needed to determine how much of the non-native DNA exists in subsequent generations (introgression).

Actions: ARS will:

- Identify and quantify the abundance of hybridization events involving key weed species and determine levels of introgression in generations following hybridization.

3. Population Structure of Weeds

Importance: Within a weed species there can be many genetically distinct populations that vary in characteristics such as invasiveness and drought or cold resistance, as well as resistance to herbicides and highly host-specific, biological control agents. Molecular methods are usually required to obtain this population structure information and may be critical to efficient control methods in some weed systems.

Research Gaps: The distribution of genetically distinct populations of key weed species across the United States is often unknown.

Actions: ARS will:

- Use DNA analyses to determine the population structure of key weed species.

4. **Unknown Origin of Genetically Distinct Populations of Weeds**

Importance: Biological control depends in part on locating insect or microbial agents that have co-evolved with the target weed. Control agents that are chosen without knowledge of the weed's origin may be ineffective, especially when the agents are highly host-specific, even to the point of preferring a genetically distinct population within a single species. Weed origins can be determined through careful study of historical herbarium records and DNA analyses.

Research Gaps: The precise origin (e.g., country) of weed species is often unknown, and complicated by controversial species names.

Actions: ARS will:

- Determine origins of key weed species or genetically distinct populations of weeds using existing herbarium collections, field surveys, and/or DNA analyses.

***Anticipated Products*:**

- Increased specimen representation of key weed species in herbarium collections.
- Original scientific treatments showing the genetic relationships among groups of weed species and clarifying controversies involving species names.
- Original scientific treatments describing existence and distributions of hybridization events involving key weed species.
- Original scientific treatments describing population structure and geographic shifts of key weed species.
- Knowledge of origins of key weed species and/or genetically distinct populations of weeds.

Potential Benefits (Outcomes):

- More accurate identifications of key weed species.
- More rapid implementation of biological control agents.
- Enhanced efficacy of biological control agents used on key weed species.
- Determination of species-based ecological range expansion potential.
- Species-specific control methodology based on taxonomic relationships.

***USDA ARS Resources*:**

- Pest Management Research Unit, Sidney, Montana
- Plant Science Research Unit, Fargo, North Dakota
- Southern Weed Science Research Unit, Stoneville, Mississippi