

## **Retrospective Review**

### **USDA Agricultural Research Service**

#### **National Program 301- Plant Genetic Resources, Genomics and Genetic Improvement**

##### Executive summary

A review panel of nine scientists was appointed to conduct a retrospective review of NP301. The international panel consisted of geneticists, breeders and molecular biologists, who are resident in three different countries. NP301 is the largest ARS national program and includes 177 research projects covering a broad range of subject matter. The program has four components, genetic resource management, genomics, crop improvement and biological and molecular processes. Only the first three of these were the subject of this review (the fourth component was recently amalgamated with NP301 and had been recently reviewed separately). The review was conducted electronically and brought together with a conference call on October 25-26, 2011. The panel was joined in the call by Deputy Administrator Dr. Judy St. John, the NP 301 National Program leaders and the process facilitator Tracy Havermann. Materials reviewed by the panel members included the Program Action Plan and the Accomplishment Report 2006-2011. The Accomplishment report was put together by the national program leadership based on input from program scientists who shaped their reports around impact statements. The leaders selected example accomplishments to illustrate the impact areas. The review panel then assessed the accomplishments in the framework of the action plan developed at the outset of the five year period. Criteria were based on achievement of goals, client satisfaction and impact of the outputs. The panel wishes to thank the National Program leaders for the work they did on the monumental task of putting together a readable and relatively concise retrospective of the accomplishments of this huge, critical program. We also wish to thank Tracy Havermann for her assistance with the process. Her knowledge, skill and cheerful manner greatly facilitated our task.

##### Panel findings

The panel agreed that the National Program Scientists are doing excellent work which is targeted at very important issues vital to food security in the USA with important implications beyond that country. The program plays a critical role in addressing issues which are not addressed by industry or other agencies. The scientists met and in many cases exceeded the goals they set for themselves. Their outputs are widely available and utilized globally with very large impacts. The United States Government is to be commended for this generous sharing of information and resources. It is extremely important to achieving food security on the planet and ensuring a sufficient supply of nutritious food for the people of all countries.

The following were the findings of the panel on a component and problem area basis.

Component 1. Problem area 1A Genetic Resource Management. -- High impact.

The US germplasm system is the most comprehensive plant germplasm collection in the world. It is well managed and the facilities well maintained. Germplasm is well described and freely available and widely used globally. Curator-user community interactions are excellent. The development of the GRIN Global database is an important contribution. There is a very high usage of germplasm which is desirable but needs to be analyzed to ensure that extra costs associated with this are justified by the nature of the requests. Data management will be an increasing challenge with the large amounts of information being generated by new technologies. The ITPGRFA and Nagoya protocol will have an impact on the operations of the system even though the USA is not a signatory.

Problem area 1B Diversity and relationships of Genetic Resources. – Medium-high impact.

This is an important area and good work is being done. Impact could be improved however with greater utilization of the new tools and information available. The NPGS is not a world leader in this area but has the potential to be and should be.

Component 2. Problem area 2A Database stewardship. -- High impact.

The USDA is the major player in this area and there is large global use of the data. Huge amounts of data are being generated in key crops and these databases are being well curated. In time it would be useful if greater harmony could be achieved between the databases to ease user friendliness and efficiency. It will be important to clearly document the resources required and importance of the curatorial role. Usage is well documented but it is difficult to gauge user satisfaction. Periodic surveys of users would help to document quantitatively and qualitatively the degree of customer satisfaction.

Problem area 2B Genome analysis. -- Very High impact.

The work in this area is extremely important and the work done on species such as maize and soybeans will have enormous impact. Due to lower industry involvement the USDA work on more minor species is commendable and much needed. The downstream impact of the data generated in this program to future work in NP301 and other breeding programs around the world will be enormous. Delivery is through the databases in area 2A and thus the growing importance of servicing that needs. The USDA plays an important training role in this area and this is not well highlighted in the report.

Problem area 2C Trait analysis and mapping. -- High impact.

Trait analysis will be a growing area as a result of the basis built though work done in area 2A. Genome Wide Association Studies have delivered a great deal of information. The generation of 20,000 soybean knockout mutants is very impressive. It will be important for not only qualitative traits but also quantitative traits as well. Work on epistasis is also an important area for future emphasis. A lot of upstream work has been done in this problem area but it is not clear how much has been applied to production agriculture. It will be important for the development of work plans to ensure that use/impact statements are included.

Component 3. Problem area 3A Genetic theory and breeding methods. -- Medium-high impact.

Improving the efficacy of breeding methodologies is an important area to address. Impact in this area is somewhat different in the anticipated products. Fundamental genetic knowledge is being well developed in this and other components of NP301 leading to a number of publications in high impact journals. This knowledge has a high potential for applied impact. Similarly a large number of markers have been developed for marker assisted selection using several technologies. The widespread use of these for the most part has yet to be realized. The ability to effectively utilize QTLs is important since many economic traits fall into this category. A number of the approaches being used however are rather traditional with limited transferability. A greater level of innovation and risk taking are perhaps warranted.

Problem area 3B Genetic resource utilization. -- High impact.

Reducing vulnerability due to narrow genetic bases in crop production systems is important to environmental and economic sustainability. There are many examples of success in developing advanced germplasm lines with useful traits incorporated in a range of important species. This is especially true of disease resistance. Work in this area needs to anticipate future needs and it is recognized that not all attempts will be successful in achieving the goals or addressing the right problem. That must be recognized in evaluating progress achieved. There appears to be a need for research on the methodologies per se of introgression of desirable traits from exotic germplasm or wild relatives. Better methods of overcoming evolutionary barriers and identification of desirable traits and elimination of undesirable traits needs to be developed. Knowledge generated in other components of NP301 should be highly relevant in this regard.

Problem area 3C Improved genetic resources and varieties. -- High impact.

Over 540 new crop varieties or germplasm lines have been developed and released in this review period. These cover a large range of crops, cereals, oilseeds, pulses, forages, vegetables, fruits and woody ornamentals. There is evidence that new methods and information are being used in the development of these materials. Variety and germplasm release avenues are well developed and effective. USDA needs to retain an active role in cultivar development especially in crop species where there is little private sector activity. It must also be recognized that such programs have suffered marked cutbacks in state and university programs in recent decades. It is also important to encourage the cooperative joint agency efforts that are ongoing. ARS needs to emphasize the value of the integrated approach and to raise awareness in governments of the important impacts of these products in environmental impact, job creation, financial gain and rural economy sustainability.