

## The development of a powerful tool for evaluating genetic diversity and investigating the genetic basis of trait variations in polyploid wheat

### Introduction

Professor Jizeng Jia, from the Institute of Crop Sciences, Chinese Academy of Agriculture Science, Beijing, China, talks about his work developing an integrated platform for wheat genomics, which led to the introduction of Axiom® Wheat 660K Genotyping Array through the Expert Design Program at Affymetrix. Professor Jia talks about the aims of his project and the challenges encountered when working with wheat, which has a dynamic and complex genome. He also discusses why he decided to use the Axiom® technology for his research, the benefits of using a screening array to select the most informative single-nucleotide polymorphisms (SNPs) for inclusion on a final array, and his experience with Axiom Wheat 660K Genotyping Array.

### Background

As the third-generation DNA marker, SNPs are most abundant and are useful for high-resolution genetic maps, marker-trait association studies, and marker-assisted breeding. SNP discovery for common wheat is a challenge because of its large genome size and allohexaploidy nature. Using resequencing data from AA, SS, AABB, and AABBDD; RNA sequencing (RNASeq) data from 32 common wheat accessions; and genotyping by sequencing (GBS) data from 78 wheat accessions (over 6 Tb of data), 51 million genome-specific SNPs were developed using the Chinese Spring survey sequence as a reference genome. Based on the score produced by bioinformatics experts from Affymetrix, four 623K arrays were manufactured and screened using a panel of 192 wheat accessions. These screening results led to the production of Axiom Wheat 660K Genotyping Array, making it the highest density wheat array commercially available. A total of 491,754 SNPs (78% of all SNPs) from Axiom Wheat 660K Genotyping Array were genetically mapped using two mapping populations. This wheat array will provide an opportunity for haplotype research in polyploid wheat, and serve as an invaluable resource for evaluating genetic diversity and investigating the genetic basis of trait variations in wheat. This array can detect 100,000 genes, which cover almost all genes in wheat.

**Affymetrix:** What agrigenomics challenges are you trying to address in your research work?

**Jia:** I have been working on wheat for more than 40 years. While wheat is a leading research crop worldwide, wheat research has lagged behind rice and other sequenced crops. One of the main reasons for this is the lack of genomic sequence and fine mapping information. We set out to sequence the D genome of wheat, and later resequenced approximately 100 wheat varieties. From this work, 51 million SNPs were discovered, leading to the development of Axiom Wheat 660K Genotyping Array. We are applying Axiom Wheat 660K Genotyping Array to analyze the wheat HapMap, gene cloning, and genomic selection.

Professor Jizeng Jia has been a professor at the Chinese Academy of Agricultural Sciences (CAAS) since 1995. The aim of his research group there is to develop a platform integrating genomics, germplasm research, and genomics breeding in wheat. Prior to joining CASS, he was a visiting scholar at the John Innes Centre from 1991–1992. Professor Jia graduated from the Graduate School of the Chinese Academy of Agricultural Sciences (GSCAAS) in 1982 and Beijing Agricultural University (China Agricultural University) in 1970.



“There were three main problems with the Illumina SNP arrays: (1) difficulty with genotyping due to multi-copy locations of most SNP markers, (2) less polymorphism in common wheat, and (3) insufficient numbers of markers to use. A custom array for the D genome markers was needed. To solve these challenges, we developed Axiom Wheat 660K Genotyping Array with Affymetrix.”

**Affymetrix:** Prior to using Axiom Wheat 660K Genotyping Array, what techniques were you using? What prompted you to develop Axiom Wheat 660K Genotyping Array?

**Jia:** Previously, we used Illumina® wheat 9K and 90K arrays for wheat diversity detection and mapping. There were three main problems with the Illumina SNP arrays: (1) difficulty with genotyping due to multi-copy locations of most SNP markers, (2) less polymorphism in common wheat, and (3) insufficient numbers of markers to use. A custom array for the D genome markers was needed. To solve these challenges, we developed Axiom Wheat 660K Genotyping Array with Affymetrix.

**Affymetrix:** How do your results from using the array translate into breeding decisions?

**Jia:** There are three steps:

1. Screening the SNPs associated with agronomical important traits.
2. Developing a HapMap for wheat.
3. Designing a genomic breeding array for wheat.



**Affymetrix:** What impact do you think this array will have on the international wheat community?

**Jia:** Previously, there was no ideal SNP array for wheat. With the high-density Axiom Wheat Genotyping 660K Array, the wheat research community can push the studies of wheat genomics, genetic diversity detection and HapMap development, gene cloning, and breeding.

**Affymetrix:** What is your view of the future of SNP arrays in the field of wheat genetics?

**Jia:** The first-generation molecular genomic marker was the restriction fragment length polymorphism (RFLP) marker, which only lasted for about five years (1990–1994). The simple sequence repeat (SSR) marker became the second-generation molecular marker and lasted for about 20 years (1995–2015). The SNP marker, the third-generation molecular marker, will last longer than the SSR marker and be widely applied in wheat genomics, genetics, and breeding in the future.

“The SNP marker, the third-generation molecular marker, will last longer than the SSR marker and be widely applied in wheat genomics, genetics, and breeding in the future.”

---

**Affymetrix, Inc:** (US) +1-888-362-2447, +1-408-731-5000 ■ (EU) +44-(0)1628-552550 ■ (JP) +81-(0)3-6430-4020 ■ (CN) +86-21-63915511  
**eBioscience Products:** (US) +1-888-999-1371, +1-858-642-2058 ■ (EU) +43 1 796 40 40 305 ■ (JP) +81-(0)3-6430-4020  
**USB Products:** (US) +1-800-321-9322, +1-216-765-5000 ■ (EU) +44-(0)1628-552600

**www.affymetrix.com** Please visit our website for international distributor contact information.

**For Research Use Only. Not for use in diagnostic procedures.**

P/N GGN006254 Rev. 2

© 2015–2016 Affymetrix, Inc. All rights reserved. Affymetrix®, Axiom®, GeneChip®, CoMAP™, Command Console®, CytoScan®, DMET™, Eureka™, Eureka Genomics®, Eureka Genotyping™, Expression Console™, GeneAtlas®, GeneChip-compatible™, GeneTitan®, Genotyping Console™, myDesign™, MyGeneChip™, NetAffx®, OncoScan®, Powered by Affymetrix™, PrimeView®, and ViewRNA® are trademarks or registered trademarks of Affymetrix, Inc. Please see [affymetrix.com/trademarks](http://affymetrix.com/trademarks) for a complete list of Affymetrix trademarks. All other trademarks are the property of their respective owners.