# HARDY rice: less water, more food

September 10 2007

An international team of scientists has produced a new type of rice that grows better and uses water more efficiently than other rice crops. Professor Andy Pereira at the Virginia Bioinformatics Institute (VBI) has been working with colleagues in India, Indonesia, Israel, Italy, Mexico and The Netherlands to identify, characterize and make use of a gene known as HARDY that improves key features of this important grain crop.

The research, which was recently published in the *Proceedings of the National Academy of Sciences*, shows that HARDY contributes to more efficient water use in rice, a primary source of food for more than half of the world's population.

Rice (Oryza sativa) is a water guzzler when compared to other crops. It typically uses up to three times more water than other food crops such as maize or wheat and consumes around 30 percent of the fresh water used for crops worldwide. In conditions where water is scarce, it is important to have crops that can efficiently generate biomass (plant tissue) using limited amounts of water. HARDY rice shows a significant increase in biomass under both drought and non-drought conditions. The researchers found that the biomass of HARDY rice increased by around 50 percent under conditions of water deprivation (drought) compared to the unmodified version of the same type of rice.

Dr. Andy Pereira, professor at VBI, stated: "This transdisciplinary research project involved the study of two plants. First we used a powerful gain-of-function screening technique to look at a large number

of Arabidopsis plants that might have features favorable to water and drought resistance. We were able to identify the HARDY mutant due to its considerable reluctance to be pulled from the soil and its smaller, darker green leaves. Molecular and physiological characterization showed that the improved water usage efficiency was linked to the HARDY gene."

Dr. Aarati Karaba, who worked on the project as a graduate student jointly at the University of Agricultural Sciences in Bangalore, India, and at Plant Research International, Wageningen, The Netherlands, commented: "The next step was to introduce the HARDY gene into rice and examine the features arising from this transformation. In rice, HARDY seems to work in a slightly different way than Arabidopsis but it still leads to improved water-use efficiency and higher biomass. Further studies showed that HARDY significantly enhances the capacity of rice to photosynthesize while at the same time reducing water loss from the crop."

Dr. Andy Pereira, added: "DNA microarray analysis allowed us to look at gene expression patterns regulated by HARDY. We specifically focused on genes that have gene ontology (GO) terms, namely genes that have been assigned by the scientific community to specific biological processes or functions. Using this approach we were able to identify clusters of known genes regulated by HARDY whose levels changed under conditions of plant water deprivation. We also saw distinct changes of gene clusters linked to the metabolism of key proteins and carbohydrates, which probably explains some of the feature differences we have detected in Arabidopsis and rice."

The scientists have been able to track down these improvements in water-use efficiency to a specific type of molecule known as AP2/ERF-like transcription factor. Transcription factors are proteins that bind to DNA and control gene expression and the HARDY gene encodes a protein that

belongs to a specific class of AP2/ERF-like transcription factors. Shital Dixit, Graduate student at Plant Research International, Wageningen, The Netherlands, commented: “At this point in time, we do not know the exact function of this transcription factor although we suspect that it impacts maturation processes linked to tissue desiccation. More work remains to be done to elucidate the precise function of this protein as well as the processes on which it has a major impact. What is clear is that HARDY rice offers the exciting prospect of improved water-use efficiency and drought resistance in rice and perhaps other grain or seed crops. This should contribute in a sustainable way to maintaining high crop yields under conditions of limited water availability.”

Source: Virginia Tech