ENHANCING DROUGHT TOLERANCE AND CARBON SEQUESTRATION IN WHEAT BY IMPROVING THE ROOT SYSTEM

by

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I am an alumnus of the University of Zimbabwe having graduated with a BSc. Honours in Agriculture from the department of Crop Science. I did my MSc studies at the University of KwaZulu-Natal (UKZN) of South Africa. I went on to enroll for PhD studies at the African Centre for Crop Improvement (ACCI) of the UKZN in collaboration with the Institute of Research and Development in Paris, France (IRD) with funding from the Water Research Commission of South Africa (WRC) and National Research Foundation of South Africa (NRF). My interests are in rooting systems of crops for drought tolerance and carbon sequestration hence for my PhD studies investigated the possibilities and benefits of optimizing biomass allocation and improving the root system of wheat.

In almost all the cases, the ultimate objective of plant breeding is to increase yield productivity. However, that end goal is achieved using different strategies and approaches. Traditionally, yield gains have been achieved by improving secondary traits related to grain yield. Unfortunately, much focus has been to above ground traits such as plant height, tillering capacity, and high-density tolerance among others to the detriment of below ground traits including root biomass and architecture. Over the years, breeders have paid less attention to roots partly because of the difficulties associated with root phenotyping and less regard for indirect benefits derived from improved root systems compared to the direct benefits from traits such as high harvest indices.

The benefits of improved root systems are numerous and include ecosystem services such nutrient and water recycling in the soil, support for microbial activity for symbiosis and improved tolerance to edaphic constraints. Old and obsolete varieties have prolific root systems that rendered more drought tolerant but gradually they have been replaced by modern cultivars that have high harvest indices but are highly susceptible to abiotic stresses especially drought and nutrient deficiency stress. Over the years, there has been extensive selection within a narrow genetic base in many national programs especially for elite crops such as wheat and maize that enjoy huge amounts of attention from the research community. Consequently, their genetic diversity for root traits has diminished considerably to levels of concern in the face of climate change. It is against this backdrop that a project focusing on assessing genetic diversity for rooting ability was initiated to respond to the needs for improved cultivars.

It was envisaged that improving the root system in wheat would provide a double-pronged solution to poor soil health and drought stress challenges. The improved root system will increase exploration for soil moisture especially in sub-Sahara where wheat is established with residual moisture from preceding summer season and has to contend with terminal drought stress later in the winter season. On the other hand, the deeper and denser root systems have higher ability to sequester carbon into the soil. This is a rather off-spin benefit that farmers rarely think about. Farmers are rather more concerned with high yield varieties but such varieties often fail to reach their potential because of poor soils and lack of water availability. It is also relatively harder to convince farmers to change their agronomic practices and adopt new technologies that promote zero tillage, cover cropping, mulching or afforestation to sustain the environment than it is to promote new and improved cultivars. So, if the new cultivars are “climate-smart” and possess inherent ability to improve the soil, reduce carbon emission from agricultural lands and contribute to removing atmospheric carbon dioxide, it would improve sustainability. In the long term, less fertilizer and irrigation application will ensue following improved soil health and better water retention due to larger and denser root systems. In line with modern breeding techniques, molecular characterization of a large panel of genotypes was undertaken to identify quantitative trait loci and devise marker assisted breeding for future programs. The project laid the groundwork for breeding and I spent time evaluating available genetic diversity for the end goal. This work is on-going and has been continued by other researchers and is part of a project funded by the WRC.

After my PhD studies, I took up a postdoctoral research post within the ACCI where I have been responsible for assisting students with research methods and design, data analyses and thesis write-up among other responsibilities. There have been both challenges and growth opportunities. The main challenges include interpersonal management, dealing with huge workloads and meeting deadlines for projects. Being young and relatively inexperienced, postdoctoral research is a training ground to manage and mentor a team. Despite the challenges, it has helped improve my people management skills in mentoring, planning and implementation of projects. I am grateful for the opportunities and funding that I received along my academic journey. I would encourage young researchers to take up opportunities with research organizations in other countries. This provides an important multidimensional perspective on how others operate, gives insight into work that has been carried out by others and also provides opportunities for future collaborations, especially for those who wish to pursue careers in academia. Such skills, in one way or another, would help the plant breeding and seed sector in Zimbabwe