PERSPECTIVE

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Sustaining the increase in crop production is the basic cornerstone of meeting the rising demands from population growth, changing dietary preferences and expanding biofuels use. The earlier strategy was simply to expand the area devoted to crop production. However, expanding the area for crop production is now limited and often associated with environmental concerns since it always involves the clearing of natural ecosystems, forests, and other fragile ecosystems. This has shifted to strategy such as the intensification of the crop yields of existing agricultural lands.

Recent advances in increasing yield potential have been made through the continuous breeding of high yielding varieties. This is also combined with researching on the efficient use and management of fertilizers and irrigation water, improved farm mechanizations and pest and disease resistance. It is interesting to note, however, that most of these advances have been done on plant traits related to economic yield and are above ground plant traits based on the principle of maximizing resource allocations to yield contributing traits. The current directions remain the same but sustaining the increases in yield potential posed many challenges.

The current crop production areas have declining soil fertility and increasing toxicity level of many soil elements. Further, with the advent of climate change, many of the crop production areas are also suffering from water stresses such as submergence, drought and soil moisture fluctuations or the recurrence of alternating water-logging and drought stress conditions. Research on below ground traits such as roots have been neglected for a long time, but many researchers are slowly turning their focus on this trait. The water and nutrient needed for plant growth and development are coming from the soil. Hence, whatever gained in the above-ground traits related to yield improvement, must be properly complemented by the root system. The root system, being the plant organ directly in contact with the soil, is also the first line of defense for supporting the above ground crop productivity when the soil experienced abiotic stresses such as drought, salinity,

and elemental toxicities. Thus, the current and future crop research opportunities have now shifted below ground.

The roots are more efficient when they are custom-tailored to the type of the environment they are growing. Thus, current research targeting traits for yield improvement must be complemented with a functional root idiotype unique to a particular growing environment. For instance, under a favorable environment where environmental factors critical for growth are optimum, increasing the yield potential of a particular crop is basically by improving the sink size and activity especially economic yield-related traits as well as source activity. Roots are also potential sinks, but they play a critical role in supporting the source activity in the leaves. Their contributions depend on how they developed their architectures under a certain environment to efficiently transport water and nutrients to the leaves for transpiration and photosynthetic-related activities.

The ability of roots to change its phenotype in response to the prevailing soil stress condition (root plasticity), is important for the efficient take-up of water and nutrients to support the above ground physiological activities to maintain crop productivity. Thus, root plasticity traits appropriate to a particular kind of crop production environment must be characterized and validated as to its physiological functions. The genes associated with root plasticity expressions under each crop production environment must also be identified and used in marker-aided breeding.

The potential agronomic management through the manipulation of planting and fertilizer managements and other strategies to improve a particular root ideotype is also a potential subject for further research. The interactions of roots among crops under multi-cropping systems and even with rhizosphere microorganisms to understand mechanisms for improving root architecture and functions and their contributions to improvement in plant adaptations and yield improvement is also needed.

In summary, the current trend in crop research is the development of high yielding crops and adapted to the different less favorable crop production environments. However, to maximize the yield potential and sustain the gain in yield increase, root researches (developmental, physiological, genetic, agronomic, etc.) are also necessary to optimize the root to shoot ratio for maximum crop productivity under different crop production environments.